The Quality Assessment and Assurance Division

Racah Institute of Physics

Self-Evaluation Report of the Racah Institute of Physics

Fall 2018

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1. Executive Summary

1.1. A short summary of the main strengths and weaknesses that were pointed out in the self-evaluation process.

The Racah Institute (RI) of Physics has a long impressive record of both high-level research and high level teaching. It is not an accident that its graduates found themselves with prominent achievements (from a prime minister to a Nobel laureate). Following is a summary of its strengths and weaknesses.

Weaknesses:

1. One of the main bothersome problems is a clear gender asymmetry and total absence of minorities within the faculty. Although significant attempts to solve this problem are taken, it is hard to solve at the hiring level given that only 10% of the applicants are women and none over the past 5 years have been minorities (non-Jewish Israelis), and that no compromise in academic level is accepted.
2. The undergraduate program is presently not suited for international students. Intentions to have 3rd year courses suitable for exchange students are underway. And although the graduate courses are automatically switched to English if any student requires, the international exposure is still low at the graduate level.
3. There has been a general decline (in all of Israel) in the number of M.Sc. students, making it harder to either keep or attract students to the graduate program (though the registration for the upcoming year is encouraging).
4. The department is distributed over 13 buildings (with faculty offices in no less than 7 building including split groups). This makes it hard to keep a cohesive department.
5. Some disciplines are under-represented (e.g., Nuclear Physics due to retirements).
6. Insufficient number of administrative and technical staff reduce the department's productivity.

Strengths:

1. Undergraduate and Graduate Study programs are excellent, producing first rate graduates (for example, finding themselves at the best places in the US as post-docs and even as faculty).
2. The department is young and vibrant (due to the size that has recently started increasing, about 70% of the non-emeriti senior faculty joined after 2000).
3. The department is becoming more international. John Howell, Nick Stone, Eric Kuflik and Yonathan Anahory are Americans/Canadian that decided to join the department and immigrate to Israel even though each one had options elsewhere abroad.
4. Researchers and research groups are generally very successful. A few disciplines are particularly strong at the national and international level, in particular Astrophysics, Quantum Information, Brain research and biophysics and Nonlinear Physics.

1.2. A short description of the actions the Institution, the Parent Unit, and the Department are going to take in order to improve the weaknesses that were found.

Addressing the weaknesses:

1. Women Faculty: In the hiring process of new faculty, special attention is given to hiring women (e.g., by approaching potential candidates and encouraging application). Graduating women PhDs are encouraged to pursue post-docs, with special programs at the university level.
2. Study program internationalization: The senate standing committee has recently taken the decision to have several undergraduate courses given in English. The Physics studies committee has is considering the option that the main 3rd year courses will be given in English. This will allow exchange students to join Israeli students, some of which will hopefully remain for graduate studies. The university is also planning to actively recruit potential students in China (either generally, or through bi lateral exchange programs, such as with Jiao Tong in Shanghai).
3. Graduate Students: The department has taken several measures to increase M.Sc. enrollment: (i) Standardize fellowships, (ii) Hold summer workshop for starting 3rd year students, exposing them to research. (iii) encourage undergraduate research projects.
4. Department's spread: (i) We have began holding 2 day annual retreats (from excelling undergrads to faculty) to increase departmental cohesion. (ii) A drawer plan for a large building is going to be developed, giving it a chance to materialize one day.
5. Under represented fields: The dept. has helped a particularly successful and promising PhD graduate to pursue a post-doc, to increase the availability of a potential hire in nuclear physics.

1.3. A brief summary of the extent to which the Study Program has achieved its mission, goals and learning outcomes, and whether the outcomes comply with its mission statement.

1. The graduate and undergraduate programs of the RI are at a very high level and its graduates are very successful. As such, it is meeting its main learning goals.
2. The high level of the graduate program clearly facilitates the ability to carry out the high level of research in the department, as well as vice versa.
3. The graduate program is slowly becoming more international, which will allow it to further improve and develop. For the past decade, graduate courses are by default given in English if there is any non-Hebrew speaker in class. In fact, at least one course has been given in English even though all present were fluent Hebrew speakers.

2. The Institution

2.1. A brief summary describing the institution and its development since its establishment; the date of recognition by the Council for Higher Education; details of the campus/es where the institution's teaching activities take place (number and location).

About the university: The Hebrew University of Jerusalem is Israel's premier university as well as its leading research institution. It was founded in 1918 and opened officially in 1925. The Hebrew University is ranked internationally among the 100 leading universities in the world and first among Israeli universities. It stresses excellence and offers a wide array of study opportunities in the humanities, social sciences, exact sciences and medicine. The university encourages multi-disciplinary activities in Israel and overseas and serves as a bridge between academic research and its social and industrial applications. The Hebrew University strives for excellence. It is among the top winners of the European Research Council's competitive grants to young researchers. One-third of all competitive research grants awarded in Israel are won by Hebrew University scholars.

In Jerusalem, the university maintains three campuses: the Mount Scopus campus, for the humanities and social sciences (the Faculty of Humanities and the School of Education, the Faculty of Social Sciences, the School of Business Administration, the Faculty of Law and the Institute of Criminology, the School of Occupational Therapy, the Paul Baerwald School of Social Work and Social Welfare, the Truman Institute for the Advancement of Peace, the Center for Pre-Academic Studies, the Rothberg International School, and the Buber Center for Adult Education); the Edmond J. Safra Campus at Givat Ram, for exact sciences (the Faculty of Mathematics and Natural Sciences, The Rachel and Selim Benin School of Engineering and Computer Sciences, The Center for the Study of Rationality, The Institute for Advanced Studies, and the Edmond and Lily Safra Center for Brain Sciences); and the Ein Karem Campus, for medical sciences (the Hebrew University–Hadassah Medical School, Braun School of Public Health and Community Medicine, School of Pharmacy, the School of Nursing, and the Faculty of Dental Medicine). It also maintains a campus in Rehovot, for the Robert H. Smith Faculty of Agriculture, Food and Environment, and the School of Nutritional Sciences; a campus in Beit Dagan for the veterinary hospital (The Koret School of Veterinary Medicine); and one in Eilat, for the Interuniversity Institute for Marine Sciences. The university also boasts 3 sports facilities, 11 libraries, 5 computer centers, and 6,000 dormitory beds.

The Hebrew University consists of close to 1000 faculty members, about 2,000 administrative staff, and 20,000 students from Israel and 65 other countries. The university is actively engaged in international cooperation for research and teaching. It has signed 150 agreements for joint projects with other universities and 25 agreements for student exchanges with institutions from 14 countries, in addition to numerous faculty-based exchange programs. The faculty has registered more than 7,000 patents, and faculty members and alumni have won 8 Nobel prizes, 1 Fields Medal for Mathematics, 269 Israel Awards, 9 Wolf Prizes, and 33 EMET Prizes.

Students of the Hebrew University (2017-2018)			
Bachelor degree	Master degree	Ph.D	Total
11182	5927	2338	19447

The university emphasizes excellence in research and teaching. The Office of Academic Assessment & Evaluation, which reports to the University's Academic Policy Committee (headed by the rector), monitors the implementation of recommendations provided by internal review committees and those appointed by the Council for Higher Education. The Office for Teaching and Studying aims to improve teaching practices through workshops, development of evaluation tools of effective teaching, and more.

2.2. Mission statement, aims and goals of the institution.

The Institution's Mission Statement and its Goals: The Hebrew University has set as its goals the training of public, scientific, educational and professional leadership; the preservation of and research into Jewish, cultural, spiritual and intellectual traditions; and the expansion of the boundaries of knowledge for the benefit of all humanity.

The Hebrew University's mission is to develop cutting edge research, and to educate the future generations of leading scientists and scholars in all fields of learning. The Hebrew University is part of the international scientific and scholarly network. It measures itself by international standards and strives to be counted among the best research universities worldwide.

The Hebrew University is a pluralistic institution where science and knowledge are developed for the benefit of humankind. At the same time, the study of Jewish culture and heritage are a foremost legacy of the Hebrew University.

The goal of the Hebrew University is to be a vibrant academic community, committed to rigorous scientific approach and characterized by its intellectual effervescence. These will both radiate and enlighten the University's surrounding society.

Supporting documents:

- A chart of the institution's organizational structure, and the names of holders of senior academic and administrative positions. – See **Attachment 1**
- **Table 1** (Excel appendix).

3. Internal Quality Assurance

3.1. A description of the institution's Quality Assurance policy and system, including its mechanisms, processes, and the responsible bodies for its implementation.

The Hebrew University developed an internal quality assessment mechanism. The Office of Assessment & Evaluation, which is part of the Rector's Office and headed by a full professor (currently, Prof. Berta Levavi Sivan, the vice rector), is responsible for internal quality assessment.

3.2. Describe the current Self-Evaluation process, including methods used by the institution, parent unit, and the department in its Self-Evaluation process; direct and indirect participants in the process, etc. Specify your conclusions regarding the process and its results.

Parts of these reports were written by the office of the Rector (general information about the university), office of the Dean (information pertaining to the faculty of science), and the dept. head (Prof. Nir Shaviv, who wrote the bulk of the report and edited it). Additional data was collected by the dept. head administrator (Ms. Etty Adiel), senior secretary for the physics studies program (Ms. Idit Mor-Kline), the unit for student registration and selection, the university's authority for research and development, as well as additional information from the academic staff of the Racah Institute.

The processes of collecting the data was extremely tedious (see below). However, given the significant help from the administrative staff, it was significantly better than could be expected otherwise.

3.3. Describe the consolidation process of the Self-Evaluation Report, including its preparation, final approval, and a description of the contributions of staff members to the process.

In order to simplify the process, the tables were placed online (as a google sheet), and various administrative staff with access to the relevant information updated the tables accordingly. Data collection from the faculty was achieved by setting up google forms through which the data can be entered individually by each faculty member. Scripts then used to convert these data into the format expected in this report. The problem however is that most faculty members (generally inversely correlated with age) do not follow the guidelines, complicating the data pipeline and forcing a significant part of it to be done manually.

Most of the data that was entered, was checked by additional people (e.g., the senior secretary of the physics studies made sure that the data received from the student registration and selection unit made sense, or the dept. chair went over information entered by the faculty members).

3.4. Describe the mechanism used to follow-up and address the weaknesses that were highlighted by the Self-Evaluation process. Which bodies within the institution/parent unit/department are responsible for this activity?

The Office of Assessment & Evaluation initiates timely international reviews of the academic units, and assists the units in preparing the self evaluation reports. Once a review is received, the relevant unit is asked to respond to it. The report and the response are then discussed at the University's Academic Policy Committee. This committee consists of the President, the Rector and Vice Rectors, as well as faculty members and independent, non-faculty members. The head of the Office of Assessment & Evaluation leads the discussion, which includes presentation and Q&A with the heads of the relevant academic unit. The discussion is concluded with a set of recommendations for implementation. The head of the Office of Assessment & Evaluation is then responsible to work in cooperation with the academic unit on implementing the recommendations, including required changes in policies of the school/faculty or the university in general.

3.5. Is the full Self-Evaluation Report accessible? If so, to whom is it accessible and to what extent?

The self-Evaluation reports are available on the rector's website. For example, the previous decadal review can be found at: https://rector.huji.ac.il/book/פיסיקה-2007

3.6. Second cycle of evaluation: in a format of a table, address the recommendations of the previous evaluation committee and describe the implementation and follow-up process (address each recommendation separately).

See **Attachment 2** where we attach the 2007 recommendations, the 2010 response and a 2018 follow up written with this report. Here we bring just the *abridged* 2018 follow up to the 2007 recommendations:

• To strengthen the two excellent groups in Astrophysics and high-energy physics, a Center for Astroparticle Physics should be formed, a continuation or even extension of the current Einstein Center. The sizes of these groups should be at least maintained, requiring new hiring in view of forthcoming retirements. The addition of a phenomenologist in the high-energy group is strongly recommended. If an excellent candidate is available, hiring another astrophysicist is recommended.

Astrophysics: Because of the very high standards of the astrophysics group, RI has been very picky in offering jobs, but ended up hiring Assaf Horesh and Nick Stone. Horesh is the first radio astronomer in Israel. However, with his background in Optical astronomy, he covers a wide base (including running our new 0.5m telescope). Nick Stone is an American "star" (PhD Harvard, Post-doc Columbia) who we managed to recruit. However, Tsvi Piran and Avishai Dekel are retiring soon, and Jacob Bekenstein passed away in his retirement year. Over the past several years, the now 5 member group has been responsible for 1/3 of the papers coming out of the Racah institute and 1/2 of the citations. Astrophysics has been part of an iCore center of excellence centered at HU.

High Energy: The Racah Institute has been successful in hiring several high energy people, including Michael Smolkin in High Energy theory, as well as Yonit Hochberg and Eric Kuflik (in High Energy

Phenomenology). With the hiring of the latter two, RI finally managed to hire phenomenologists after having sought people in the discipline for 25 years without success. They are extremely active (arriving with about 5 grants and 2 post-docs already from day one).

Other groups have also had successful hires, solidifying their leadership. In particular, quantum information (with people also in other departments in the faculty of science and school of engineering) is a very strong group that became extremely strong with the hire of Prof. John Howell.

• The newly formed biophysics group, currently only two faculty members, should be expanded to a “critical mass” of 4-5 members. A high priority should be assigned to the development of biophysics courses within the curriculum, at both elementary and advanced levels. Collaborative ties with the life sciences department are strongly encouraged.

Two new full time faculty (Eilon Sherman and Ady Vaknin) have been hired, in addition to a couple of partial appointments (e.g., Yoram Burak who is half in Brain Sciences). We are thus approaching the “Critical mass”, however, we are are still missing a high quality theorist to augment the group.

• Immediate addition of an electronic support person and at least 1/2 of a computer support person are strongly urged. The administrative and machine shop staff should also be enlarged.

In addition to the full time system administrator, the astrophysics group has kept a full time system administrator on soft money - mostly the iCore center (the group has a large cluster and carries out computationally intensive work). The university’s goal is to have 1/2 a technician for every experimentalist, and 1/5 of a system admin for computationally intensive faculty. We are far from there. With regards to the machine shop, it has undergone a major upgrade. We have raised the money and installed a 5 axis CNC machine and hired higher qualified staff. We are now boosting the electronics workshop. In this respect, it should be mentioned that faculty from the department helped establish on campus a 3D printing lab that allows students and researchers to fabricate on campus.

• The number of teaching assistants in the physics courses should be increased so as to allow the marking of weekly assignments and to keep recitation classes to a size of 30-35 students at most.

This hasn’t changed much. The university has been in a prolonged budgetary crisis which gave rise to the shrinking of TAs positions and recitation classes. Only recently has it signed an agreement with the PBC and entered a recovery plan that will lead towards growth. We haven’t seen the fruits yet at the department level, except for (the very important!) increased hiring with generous startup packages. We hope that in a couple of years the TA related teaching will improve in quantity).

• The number of elective courses, particularly in the M.Sc. and Ph.D. curricula, should be increased to allow for a larger flexibility in the choice of courses.

We have had a problem with offering many elective courses with the small number of faculty. However, with the recent hiring and department increase from about 33 at the minimum to 40 faculty members, this has improved significantly.

• The entire Racah Institute should reside in a single building.

Unfortunately this hasn’t been done yet as there wasn’t any support from the university administration. One faculty member (Nadav Katz) took upon himself to start working on a plan even without administration support, so that once an opportunity arises, it could be seized.

4. The Parent Unit

4.1. The name of the parent unit, its mission statement, aims, and goals.

The Faculty of Mathematics and Sciences was founded initially as the Faculty of Mathematics. Its first Dean, Prof. Abraham Halevi Fraenkel, joined the university in 1929, four years after the foundation of the Hebrew University. In the two following years the Microbiology, Chemistry and Physics Departments were established and were later joined together to form the Faculty of Science. The War of Independence in 1948 left the University's campus cut off from Israeli west Jerusalem, and alternative facilities were located throughout the city. In 1953, construction began on a new main campus on Givat Ram in the heart of Jerusalem (currently the Edmond J. Safra Campus). During the Sixties and Seventies the research and teaching activities were all transferred to this campus.

The two major missions of the Faculty of Science and Mathematics are as follows:

- Learning, Teaching and Educating – The Faculty of Science attracts some of the best students in Israel. The Faculty's aim is to offer them a high level of teaching and training at both the undergraduate and graduate levels, which is based on front-line academic and scientific expertise and advanced research facilities, aiming at generating highly professional graduates, prepared to cope with any future scientific and professional challenges.

- Research – The level of research carried out in the Faculty of Science is one of the highest in the world. The ranking of this Faculty by the Shanghai Academic Ranking of World Universities has been typically between 76 to 50'th in the world (peaking at 35 in 2011). In their work, spanning many varied disciplines, our scientists and research students contribute to the store of knowledge worldwide. The Faculty's aim is to maintain top class scientific research in all of its varied disciplines by providing its faculty members, both junior and senior, with advanced facilities and means and by monitoring strictly their academic achievement record.

4.2. What is the decision-making process for the rationale, mission, and goals of the parent unit? How are they reviewed and monitored?

The body that is academically responsible for the teaching programs is the Faculty's Teaching Committee. It is headed by the Vice Dean for Teaching and it comprises the heads of all the Faculty's teaching programs (including the Head of the Biotechnology Graduate Program) and students' representatives (the Dean is an *ex-officio* member). The main responsibilities of the Faculty's Teaching Committee are to propose, discuss, approve and monitor all the Faculty's teaching programs including interfaculty as well as interuniversity programs. Depending on the issue at hand, new programs are submitted for ratification by the University's Standing Committee and – if required – by the Council for Higher Education. Changes in teaching programs, goals and missions are delegated to the Faculty and students, via the corresponding members of the Faculty's Teaching Committee.

4.3. List of the committees operating within the parent unit, and their composition (representatives of which departments/bodies are members).

Faculty Appointments committee: Headed by Prof. Nissim Beneveniste, includes the department head, additional representatives as well as a representative from the humanities or social science. The Dean serves as an observer.

Promotions committee (with tenure): Headed by Shmuel Wolf: Representatives from various dept, including from non-science.

Promotions committee (without tenure): Headed by Prof. Oded Millo Representatives from various dept, including from non-science.

Teaching committee: Headed by Prof. Oded Millo, includes the program heads (such as of the physics studies), and additional representatives. The Dean serves as an observer.

Note that the committees are joint with the independent school of engineering.

Supporting documents:

- A chart of the unit's academic and administrative organizational structure (including relevant committees), names of holders of senior academic and administrative positions, and a list of departments/study programs operating within its framework. – See **attachment 3**
- **Table 2** (Excel appendix).

5. The Department/Study Program

5.1. Study Programs

5.1.1. **Overview**, addressing the following:

5.1.1.1. The name of the department/study programs, and a brief summary describing its development since its establishment.

History: The first steps towards a physics department at the HU were taken already by Chaim Weizmann in 1913, who approached Leonard Ornstein, to prepare the plans for physics research at the about to be established university. The idea of having physics at the new university was in fact continuously backed by Weizmann, Fraenkel, Ornstein and Einstein. Ornstein orchestrated the organization from his seat in Utrecht. In a 1931 meeting of the board of governors of the Hebrew University in Zurich, it was decided that a "course of general physics will be given as a secondary subject towards an academic title", and thus the first physics program in Israel was established. The first physicist to be appointed was Shmuel Sambursky in 1928, followed by Ernst Alexander and Guenther Wolfson who left Germany in 1933. Attempts to hire Block, Wigner and London were serious but eventually failed. George Placzek even accepted but left after a few months due lack of experimental infrastructure. Finally, Giulio Racah, a young and idealistic professor from Pisa (who grew in Fermi's group and worked with Pauli and Bohr) joined in 1939. Racah turned the department into a world center for atomic spectroscopy, and after his death, the department was named after him. Being the first and foremost physics department, the Racah Institute of Physics (RI) has over the years educated a large fraction of the physics leaders in Israel.

Leadership of the Institute: The Racah Institute is formally directed by the chairman of the Institute (Presently Prof. Nir Shaviv). However, the Institute leadership is shared with the head of the physics program ("Hug"), an additional faculty member who is responsible for all the physics studies (Presently Prof. Ronen Rapaport). Both the program head and chairman are professors at the Institute and are elected by the Institute's faculty for 3 year terms (and very rarely extended to 4).

The functions of the head of the physics program are: responsibility for the course curricula, placement of the teaching staff in the courses, approval of all examinations and grades, and on-going contact with both undergraduate and graduate students. The chairman of the institute is responsible for all the other academic activity in the institute. Namely, he or she are responsible for the Institute's academic development, recruiting, and infrastructure. The chairman is also responsible for all administrative functions and the Institute's non-academic staff. However, the day to day administrative activity is handled by a senior administrator (Presently Ms. Etty Adiel). Thus, the Institute is effectively run by three heads – The head of the physics program, the chairman handling non-teaching academic activity and long term development, and the head administrator handling finances and day to day administration. The Physics program office ("Hug") handles all the administration related to teaching undergraduate and graduate courses as well as all the administration related to graduate students (except for the formal administration of PhD students which is handled by the authority for research students). Its budget is an integral part of the RI's budget.

The RI has several permanent and ad-hoc committees. The first permanent committee is the selection committee (headed by a professor other than the department chair – presently Prof. Nathalie Balaban) which is responsible for providing the chair with a ranked list of candidates for faculty hires. The second committee, headed by the head of the physics program, is the teaching committee described below.

Various additional committees are occasionally formed. For example, an infrastructure development committee (headed by Prof. Eran Sharon) have been convening over the past several months in order to create a development plan. Due to complex "geographical" constraints and present growth, it is not trivial to establish new research groups while ensuring the researchers of different disciplines remain physically close (or better, bring together researchers in cases groups are still physically spread).

Major changes in policy and/or the studies curriculum are discussed and ratified by votes taken at faculty meetings, which generally take place biannually.

The Physics Program: The Physics study program includes several undergraduate degree programs as well as a research master program and a PhD program.

The undergraduate degree programs include an extended physics (single major) degree, a "normal" single major degree, and physics as part of a double major. The latter includes a standard physics as a double major option, as well we several tailor made double major degree options. Last, there is also an option to take physics as a minor.

Thus, a full list of the programs handled by the physics studies program includes:

Standard	Physics - Single Major
	Physics - Single Major extended
	Physics as part of a double major
	Physics as a minor ("Hativa")
Specialized single major	Physics with specialization in Quantum Information
	Physics with specialization in nano-science and technology.
Specialized double major	Biophysics - Physics and Biology as a double major
	Physics and Environmental Science
	Physics and Mathematics - double major
	Extended Physics and Mathematics - double major
	Physics and Extended Mathematics - double major
	Physics and Earth Science double major (with specialization in atmospheric science)
	Physics and Earth Science double major (with specialization in geology)
	Physics and Cognition double major
Masters	Master in Physics
PhD	PhD in Physics
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Talpiot Programs	Physics single major
	Physics and extended math double major
	Extended physics major and minor in math
	Physics major with minors in mathematics and computer science
	Physics and computer science double major

Note that there are a few addition programs of which the administration is handled elsewhere (though the physics courses are given by the physics studies program). These include the joint double major programs in physics and chemistry, as well as the Amirim excellence program.

5.1.1.2. The department's/study programs' mission statement, aims and goals. What is the strategic plan of the department and its study programs? (Address the decision-making process, revision, and monitoring).

Since its establishment, the Institute has seen its role as a dual one, to strive for excellence in basic research and to provide both undergraduate and graduate level education at the highest level possible. The "hands-on" education necessary to produce top M.Sc. and Ph.D. graduates can only be produced by a research university with a high-level research program. Conversely, high level research requires high level students. Clearly, education and research are equally important, and they reinforce each other. This is also reflected in the dual academic leadership structure of the institute.

5.1.1.3. List the bodies responsible for planning and managing the study program. Describe the mechanisms responsible for introducing changes and updating the study program and how they operate. Specify any fundamental changes in the study program during the last five years, as well as recent and planned (upcoming year) changes in the study program.

The day to day activity of the study program is run by the program head, a senior secretary (Presently Ms. Mor-Kline) and an additional secretary. Some of the regular decisions (e.g., acceptance of PhD students is approved by a larger body consisting of the present and a former program chairs as well is the dept. chair. However, major changes are brought for a discussion and decision by the program teaching committee at least once a semester. The committee consists of about a dozen members, and it is the main body responsible for overseeing the study program and introducing changes, such as approving new courses, changing course syllabi, changing acceptance criteria, as well as approving TA-ships.

In addition to the program teaching committee, there is a faculty teaching committee of which all the program heads from the different departments are members (as well as the vice dean for teaching). This committee oversees the teaching activities in the whole campus (of the faculty of science and the school of engineering).

The main changes that took place in the study program over the past 5 years include the following:

a) The 3rd year lab was halved from an annual course into to a one semester course. Students are required to instead to take more electives or carry out a senior research project.

b) Following a very detailed study correlating study success (and more specifically, failure rate), with the entrance acceptance scores, the acceptance criteria were increased to decrease the failure rate, while making sure that they do not filter out able students. Interestingly, this increase actually increased the registration and acceptance numbers.

5.1.1.4. Describe the mechanism for coordinating and examining the contents that are, in fact, being taught, if such a mechanism exists.

Course contents are discussed in the teaching committee. Occasional discussions are usually prompted by teachers of other courses when they notice that their students are lacking necessary backgrounds. More organized course syllabi are reviewed every several years when various topics are discussed (for example, how quantum mechanics is taught – what material by which courses) to ensure that the program is optimal – that there are important topics which are missing, or conversely, that there is no significant overlap between courses.

5.1.1.5. List the courses provided by the department to other units, if such courses exist.

There are two types of courses given by the department to other units. The first are basic physics courses for science majors – engineering, chemistry, earth sciences, biology and medicine. These service courses are generally given at the Giv'at Ram / Safra campus. The second type are part of the corner stone program through which non-science majors are exposed to scientific topics (and vice versa). Because these courses are relatively large, about a 1/4 of the student-credits taught by members of the RI are through such service courses.

Basic physics for various science majors	
77100	Mechanics and special relativity for Odyssey program
77104	General Physics (2) For Pharmacy Students
77112	Electricity, Waves and Optics - For Bio-Med. Students
77116	General Physics (1) For Pharmacy Students
77130	General Phys.- Mechanics For Chem. & Earth Students
77131	General Phys.- Waves & Elec. for Chem.& Earth stu.
77141	Mechanics for Med. students
77142	Basic electromagnetic and wave theory for Med. students
77148	General Physics - Mechanics - For Biology students

77188	Mechanics for Bio-Med. Stud.
77304	General Phys.: Elect. & Optics For Biology Students
Corner Stone Program:	
77118	Astronomy for Poets
77132	Physics for Decision Makers

5.1.1.6. List the non-academic bodies involved in the running and the activities of the parent unit and study program, if such bodies exist.

There are no non-academic bodies involved in running the activities of either the parent unit (the faculty of science) or the study program.

5.1.1.7. Research of undergraduate students:

5.1.1.7.1. To what extent are the undergraduate students involved in research projects of faculty? Is there a structured mechanism (e.g. courses; credits for participating)?

Until a few years ago, undergraduate projects could be done as either the senior undergraduate research program of the "Amirim" excellence program, or relatively rarely, as an experimental project instead of half the 3rd year physics lab. Some students also did research or helped doing research, not for credit, but for a salary.

A few years ago, it was decided to cut the advanced 3rd year lab, and instead encourage doing undergraduate projects (for credit). This gives more students hands on experience in forefront research already as undergraduates. It also helps get more students interested in continuing for masters working with members of the Racah Institute.

5.1.1.7.2. Is there a procedure for encouraging students to carry out independent research?

Third year students are encouraged to take the course "introduction to research" in which various faculty members present forefront research in their fields. This encourages students to seek projects in related topics.

5.1.1.8. In summary, to what extent has the program achieved its mission and goals? What are its strengths and weaknesses?

Given the success that our undergraduate students later have as graduate programs (whether at the HU or elsewhere) and given the success that out former graduate students have as post-docs abroad and later as faculty, we believe that our undergraduate and graduate research programs are generally very successful in providing a broad physics education, ranging from theoretical to experimental.

One of the major strengths of both the undergraduate and graduate programs is that the courses are given by researchers who are carrying forefront research, and as such can keep the teaching level as high as one can expect from the best universities. At the graduate level (whether M.Sc. or PhD), the students can carry out forefront research with these faculty members. Most also get the valuable experience of being teacher assistants.

One major problem that existed over the past two decades is the decreasing number of faculty members. As a consequence, the number of elective courses dwindled or given relatively infrequently. With the recent increase in faculty members, this problem is subsiding. Another problem that has existed due to financial constraints has been the reduction in the number of recitation classes provided to mostly elective courses. With the recent improvement in the financial state of the university, we hope that this could improve in the near future.

Supporting Documents:

- A chart of the academic and administrative organizational structure of the department and its study program/s (including relevant committees and names of senior position holders). – See **attachment 4**
- A flow chart of the program presenting the process of completing the degree fully. The chart should present the "program at a glance" at all degree levels. – See **attachment 5**
- **Table 3** (Excel appendix).
- Table/list: research projects and number of undergraduate students involved. – See **attachment 6**

5.1.2. Internationalization

5.1.2.1. What is the international strategy of the institution? How is it reflected in the mission and goals of the department/study program?

Until recently, internationalization of the study programs was not specifically addressed at the the university level. At the department level there was no active recruit of international students. The graduate program itself however has been open to international students for many years. It is about a decade now that all graduate courses are given in English if there is at least one non-hebrew speaker in class.

Over the past 3 years, the total number of Master students (studying at some point or another) has been 134, of which 3 were foreigners. At the PhD level, the respective numbers are 120 and 7, i.e., almost 6%. At the post-doc level, the numbers flip. 44 out of the 58 post-doc over the past 3 years are foreigners, i.e., about ¾ of the total number.

At the research level, the department is extremely international, with the researchers maintaining close ties with collaborators abroad. Thus, there is always a steady influx of foreign visitors coming to collaborate and give seminars.

5.1.2.2. List the international features of the department/study program, if exist.

The graduate program is defined to be in English. (Courses are given in Hebrew only if everyone in class is a fluent Hebrew speaker).

About a fifth of the faculty members did at least some of their formal studies abroad. All the rest, with no exception did at least a post-doc abroad. So the faculty has significant international connections.

Supporting Documents:

- Table: number of international students, including both local students studying abroad and international students coming into the department/study program.
- **Table 4** (Excel appendix).

5.2. Teaching and Learning Outcomes

5.2.1. Teaching

5.2.1.1. List the institutional Quality Teaching activities offered: training of new and existing faculty (including adjunct faculty), support for teaching technologies, etc.

The unit for teaching and learning at the university offers a wealth of teaching skill improvement courses and workshops. These include general teaching skills, teaching with presentations, discipline in teaching, teaching large classes, the challenge of activity based teaching, etc. All new faculty members have to take the basic teaching workshop before their tenure procedure is opened.

Faculty who receive relatively low grades in the teaching survey are generally asked to take a personal mentoring program given by the unit for teaching and learning. In it, professional staff of the unit visit and record several lecturers, and then sit with the lecturers to pin point where they can improve their teaching.

On the technical side, the faculty of science keeps technical teaching staff who help introduce new teaching technologies. Today for example all introduction courses and most of large more advanced undergraduate courses are video recorded and uploaded to the course website where students can watch again to better understand hard topics, or fill missed lecturs. Most courses have organized websites on the university Moodle system. The department keeps technical staff to run the teaching laboratories and class demonstrations.

5.2.1.2. Teaching regulations and information: list the regulations that address student-faculty relations in terms of teaching obligations (deadlines and schedules, availability, etc.), regulations regarding content and publication

of syllabi (including the coursework and grading structure), and the mechanism for publishing and disseminating the information to students.

The university has organized bylaws governing the faculty-student relations in general, and bylaws pertaining to teaching. These include for example the right for a 2nd exam (Moed Beit), the requirement to submit exam grades no later than 10 days after the exam, or the publication of updated course syllabi and grade structure at the beginning of the course. The rights are summarized here (in hebrew): https://studean.huji.ac.il/book/זכויות. See also **Attachment 7** for an English version.

Course information is generally sent via email (e.g., through Moodle messaging), to university e-mail accounts that each student has.

5.2.1.3. Teaching surveys: describe the institutional system (frequency, percentage of courses addressed, the process of evaluation, responsible bodies for feedback and follow-up, etc.).

Every semester, all students are asked (but not forced) to fill in online teaching surveys for each course that they have taken during the semester. These surveys are run by the unit for teaching and learning. Course and teacher grades are then generated for the courses for which there were at least 6 responses. The results are then sent to the head of the physics program as well as the faculty members. The surveys are important as they play a role in awards (teaching award, rector prize), as well as in discussions for tenure and promotion. As such, people take them seriously. From last year, they also serve as one of several criteria required to get the "criteria component" of the salary. **See attachment 8** for an example (in Hebrew)**.**

Some head of programs (with the previous one being a good example), use the teaching surveys to shuffle the courses taught by faculty in order to increase the overall student satisfaction from their studies.

5.2.2. **Learning Outcomes**

Learning outcomes are what students are expected to know, understand, or be able to do as a result of their learning experience:

5.2.2.1. List the program's Intended Learning Outcomes (ILO). How were they set and where are they stated? Please refer to each track and each degree level separately. In framing your response, consider the following:

5.2.2.1.1. Specify what the ILOs of your program are.

5.2.2.1.2. Emphasize wanted competences, skills, and impact of the program.

5.2.2.1.3. Clearly describe skills and competencies, rather than just content knowledge. An example could include the following description: 'at the end of the degree…the student should be able to…'

By the time the students graduate with a major in Physics, they will have the following skills and competencies:

- They will understand and will be able to solve basic problems in a wide range of core physics areas which include mechanics, special relativity, analytical mechanics, electricity and magnetism, waves and optics, electrodynamics, quantum mechanics, thermal physics and statistical mechanics.

- They will have the mathematical skills necessary to solve the above problems (within the fields of Calculus, Linear Algebra, Complex Variables, Ordinary and Partial differential equation, Variational Calculus, Integral Equation, Probability and Statistics).

- They will understand and be able to solve problems in a large fraction of the following topics in physics: Astrophysics, Particle Physics, Nuclear Physics, Condensed matter physics, Biophysics, Fluid Mechanics, General Relativity, Plasma Physics.

- They will have laboratory skill which will allow them to setup experiments to answer physics related questions such as hypothesis testing, how to conduct measurements reliably and carry out error analysis.

- They will have skills expected from physicists, which include the ability to model systems, find exact and approximate solutions, use dimensional analysis and other methods to study the physical systems, and have the ability to validate solutions.

- They will be able to use a computer language (generally Python) and numerical tools (Matlab) to help solve problems.

5.2.2.2. Who writes and grades the examinations and exercises? How is their validity assessed?

In courses in which there are no teacher assistants, the examinations are written and graded by the course teachers. Since grading course exercises in large courses can be a lot of work, most large courses have exercises that are not to be submitted.

In courses in which there are teacher assistants, exercises are generally written by the teacher assistants with guidance by the course teachers. The exercises are then graded by the TA's if they have sufficient time for it. The exams are written by the course teachers, however the course TA's often suggest questions as well. Exam grading is usually split between the lecturer (or lecturers) and TA's (with general guidance given by the lecturers).

5.2.2.3. Who grades the written assignments? Describe the methods applied to evaluate written assignments and projects. What kind of feedback, apart from the grade, is given to the students?

Assignments related to the Labs (such as preparatory and post-experiment reports) are generally graded by the Lab TA's. In the few courses that have projects, these are generally graded by the lecturer.

5.2.2.4. Training and field work:

5.2.2.4.1. Describe the training/field work required in the program, including its contents and scope.

5.2.2.4.2. Describe the methods applied to evaluate training/field work. What kind of feedback is given to the students?

There is no training/field work in physics.

5.2.2.5. Any other methods applied to measure the achievements of the students.

Most courses have final exams. A few basic courses have also midterms (primarily to help the students get ready for the final). Some courses have written exercises which are graded. A few courses have projects. Lab courses are graded based on the reports written and presentations given by the students and their interaction in class with the TA's and lecturer. The 3rd year seminars are graded based on performance in class. See also **Attachment 9**.

5.2.2.6. In summary, to what extent have the methods applied to measure the teaching and learning outcomes achieved their goals? Are the ILOs achieved by the students?

Most of the aforementioned goals are to a large extent achieved. The weak side is the ability to continuously monitor through the grading of home exercises, due to the limited TAship resources.

Supporting Documentation:

- Table: method of examination and the percentage of its use in the program.
- Histogram: distribution of the final grades over the last three years (in all degree levels). – See **Attachment 9**
- List of places of training (including the number of students in each). – **Not relevant.** All studies are carried out in Giv'at Ram / Safra campus.

5.3. Students

5.3.1. Admission and Graduation

5.3.1.1. How are the admission criteria to the program decided upon?

The admission criteria from the undergraduate and graduate programs are explained in detailed in **attachment 10**. Basically, a candidate can be accepted based on Matriculation Exams, Psychometric Exams, or a combination of the two, whichever options is best. We note that the minimum requirements were increased over the past year (e.g., a combined score of 20 instead of 19.25). This was a result of a detailed analysis (lead by Prof. Nir Barnea and the previous head of the physics program, Prof. Barak Kol). The analysis considered the long term success rate of the students based on their admission scores, and in particular, their dropout rate from the program (usually to other science programs in the faculty of science). The new requirements were chosen to optimize student success, minimum filtering of able students, and minimize the acceptance of students that will later drop out. **See attachment 11**, which is a presentation summarizing the main findings of this analysis.

The result of this increase in the minimal criteria was an *increase* in the total number of students registering to the program in 2018 by 12% (probably by making it more prestigious). We note that in Math there was a similar increase from 19.25 to 21, and there was a 26% decrease (probably filtering out too many students).

5.3.1.2. Describe the policy of affirmative action within the program.

The acceptance to the university's bachelor programs include a social advancement acceptance route. Candidates who matriculated from a given set of high schools (in the various Arab sectors, from Jewish social periphery, and Orthodox schools) have more lenient acceptance criteria, e.g., 10.15 instead of 10.50 if based on matriculation exam alone, and 640 instead of 675 if based on psychometric exam alone.

5.3.1.3. Describe the selection and admission process, the criteria of advancement from year to year and for completion of studies, including the requirements for being entitled to receive an academic degree.

Students register to the program through the university's online registration system. The admission criteria (described in **attachment 10**) appear online and any student knows in advance whether he or she can be accepted or not. Registration according to these criteria is open until May of the preceding academic year. Beyond that, the registration can close or can remain open (optionally with a higher admission cutoff) if the quota did not fill.

Since the compulsory courses are needed as prerequisites for subsequent years, a minimum passing grade of 60 is required in these courses in order to take the compulsory courses of the subsequent year.

5.3.1.4. Describe the department's policy regarding dropping out.

The official bylaws allow repetition of a year no more than once (longer if the student was pregnant or had particularly long reserve service). However, in most cases were students have a problematic academic standing, the head of the physics program tries to find a solution with the student that will allow him or her to continue if possible. See **attachment 7** for the university bylaws pertaining to student studies.

Supporting Documents:

- Table: entry requirements/criteria for the program (first degree and advanced degrees including "on probation" status). See **Attachment 10.**
- Histogram: the range of psychometric test scores (or the equivalent) and the range of matriculation averages of the students that were

admitted to the program in the last five years. See **Attachment 11** for a presentation analyzing various aspects of the acceptance and failure rates of students based on the admission criteria.

- **Tables 5-6** (Excel appendix).

5.3.2. Graduate Studies

5.3.2.1. Specify the structure of the graduate program (MA and PhD), including official and de facto period for completion, and the mechanism for monitoring students' progress.

Admittance criteria for the graduate programs is described in **attachment 10**.

The M.Sc. program includes 35 credit points and a research thesis. The courses include two compulsory courses (in advanced quantum mechanics and advanced statistical mechanics). And 6 groups of courses from which at least 17 credit points have to be taken (from at least 3 different groups). The rest of the credit points can be taken either from the groups or from a list of about 2 dozen elective courses.

The submitted thesis is sent for grading by independent reviewers. There is a final exam by a committee of faculty members which asks questions on both the research project as well as other courses that the student has taken during his studies.

The M.Sc. program is supposed to be 2 years long for full time student, though occasionally it lasts longer (typically another semester). Students cannot TA in their third year, and they require special approval to be payed a fellowship in their third year.

Students without a fellowship and working elsewhere (or serving in the army) can and do extend the program longer for obvious reasons.

The PhD Program includes taking 12 credit points in courses and carrying out extensive research. In the first stage of the PhD, the student commences their study and research of an advanced topic. Towards passing to the 2nd stage, the student has to submit a research proposal and an "accompanying" committee (va'ada Melava) is established (which includes the advisor and at least 2 more people, of which at least one has to be from outside the institute).

The committee convenes, grills the student and decides if the student is ready for passing to the 2nd stage. The committee can also decide if additional courses have to be taken. Towards the end of the research, the student has to give a progress lecture, and the committee has to convene again and decide if the student is ready to write and submit the thesis.

Once the thesis is submitted, it is sent for review by reviewers outside the university (including reviewers abroad), who can ask for example for correction and resubmission of the thesis.

The PhD nominally lasts 4 years, but occasionally overflows to the 5th year. Beyond the 4th year a student cannot serve as a TA. Paying a fellowship in the 5th year requires permission by the school of graduate studies.

5.3.2.2. Describe the policy regarding advising graduate students.

M.Sc. Students are expected to find an advisor by the beginning of the 2nd semester of the 1st year. Other than that, there are no particular policies other than the university's general regulations.

The registration for PhD studies require the student to have a willing advisor at the time of registration.

5.3.2.3. List the mandatory/elective courses that provide and teach research skills/soft skills.

At the bachelor degree level, most of the courses provide "hard" skills. However, there are several elective courses which teach soft skills. These include:

- Advanced lab, which is the 1st year Lab augmented with a half year experimental project.

- Order of magnitude physics: This is a course in which students learn how to deal with less defined physics problems they will encounter while doing research or later when they work as physicists. It was modeled after a similar course given at Caltech.

- Undergraduate research project: Through this project, students have the opportunity to experience and learn through carrying out advanced research.

At the graduate level, the research projects require the acquirement of the relevant soft skills. The main difference between the PhD and MSc projects is that PhD requires and therefore teaches more independence.

5.3.2.4. Is there a departmental seminar? Do graduate students participate in it?

There is a weekly colloquium during the semesters in which the master students are required to participate.

5.3.2.5. Describe the financial support system available for graduate students.

At the MSc level, all students accepted above a certain threshold receive a TA position paying for a salary and a fellowship, which together come up to be around 6000 NIS/mo (which includes a fellowship higher than the 100% level defined by the university). The top 25% receive a total of 7000 NIS/mo. The first semester is covered by the department. The next 3 semesters have to be covered by the supervisors. There are very few prize fellowships.

At the PhD level, there are no internal regulations on how much should be covered. Most students receive TA'ship (which is decided upon by the teaching committee based on merit). Fellowships are entirely covered by the student advisors. There are virtually no university fellowships to help (there are a few external fellowships). The combined TAship and fellowship students receive typically range from 9 to 12 kNIS/mo. These are well above the 100% fellowship as defined by the university. There are no internal regulations on what they should be, but one option which is now brewing is to standardize the fellowships as we did at the M.Sc. level 3 years ago.

5.3.3. **Student Support Services** - institutional and departmental

5.3.3.1. Describe the system of academic counselling for students before and during the period of study (including reference to the structuring and approval of the study curriculum).

Students can receive academic counselling through several means:

- Each year (including for the master students) has an academic counsel.

- The physics program secretaries readily help students if they require administrative and some academic counselling (in fact, the head secretary received an award from the university).

- The heads of the physics program have always been available to help students as well.

- A new program started this year of mentoring by the faculty members. Each faculty member receives a list of several students with whom he or she meet at least once a semester. Students get to meet faculty in person, interact, and get advice.

5.3.3.2. Do students with special needs receive special support? If so, please specify.

There is a special unit at the university level to help students who require special support. This includes helping with adjustments to students with learning disabilities, students with various handicaps (such as vision or hearing impairments, or other physical handicaps). The units ensure that the special requirements are provided by the academic and administrative staff.

5.3.3.3. Describe the types of financial assistance available for students (outstanding and with financial difficulties).

Besides various external fellowships, the university provides both merit and financial based fellowships to relevant students. The merit based fellowships are given by the students administration unit. The financial support is generally managed by student dean's office.

5.3.3.4. Describe the institutional mechanism to address student complaints regarding teaching (its activity, accessibility, and how its activity is publicized to students).

Student complaints can be addressed at all levels:

- Physics Program's office (secretaries and the head of physics program),
- Student office at the faculty of science,
- Student dean's office,
- Even the rector publicized his personal contacts.
- The two commissioners for sexual harassment readily handle relevant complaints.

5.3.3.5. Describe the counselling and assistance provided to students regarding job placement (including collaboration with employers and the employment market).

There is no particular job placement counselling. However, linking students to prospective employers is done at several levels. At the institute level, we occasionally advertise particularly relevant jobs. At the faculty of science level, there are regular job fairs organized together with the student union. There is a relevant facebook page managed by students which helps with job placement. And last, the Alumni association has a website https://hujiconnect.com which provides several services, including advertising jobs.

5.3.4. **Alumni**

5.3.4.1. How does the institution and/or the department maintain contact with their alumni?

At the university level, there is an alumni association which keeps loose track of the alumni and provides several services (such as the aforementioned job placement). Presently there is little activity related to alumni at the institute level. About 5 years ago there was an attempt to organize an alumni gathering, but the turnout was very poor.

Supporting Documents:

- ☐ Table/Chart - integration of alumni into the labor market: where have they found employment, what positions do they hold, how much time has elapsed between graduation and employment. **We do not have this information.**
- ☐ Table/Chart - How many students continue their studies to advanced degrees or other areas (specify area of study and degree level). **We do not have this information.**

5.3.5. In summary, what are the strengths and weaknesses of the issues specified in this chapter?

Strengths: The undergraduate and graduate academic programs are well integrated with the research activities of the institute, and as such provide a first rate academic home for the students.

Weaknesses: a. The financial support given to graduate students is limited compared with other universities. b. The department's contact with its alumni is poor at best. This significant resource is not tapped.

5.4. Human Resources

5.4.1. Specify the rules, criteria, and procedures for recruiting, appointing, and renewing appointments and dismissals of academic staff (tenured and adjunct), including rules regarding tenure and promotion; specify the standard duration of service at each position. What are the plans for future recruitment to the study program? How are these plans made and by whom?

Recruitment at the Senior Lecturer and Associate Prof. Level: The usual hiring process is as follows.

- A job opening is advertised in the summer, soliciting applications in all disciplines of physics, with a deadline in the fall.

- Applications are then received from candidates working in a variety of fields. Typically we receive 30 applications a year.

- During the 3 month period of November through January, most candidates choose to visit on job talks (though formally it is not necessary for us to consider the candidates – on occasion we also have Skype chats with candidates). Some of the applications are the result of actively approaching excellent candidates known to be on the market.

- The selection committee deliberates half a dozen times during the period. At its end, it votes on a shortlist composed of about 10 people, and ranked by merit.

- The chair of the Racah institute is then supposed to hire with preference set by the list. Although the list is merit based, the dept. chair is required to consider additional constraints – number of positions available for hire, amount of startup funds available for experimentalists, recent hires, retirements and future development of different disciplines, as well as input form the selection committee and members of the different groups.

- Once the relevant candidates are decided upon, the dept. chair requests additional letters of recommendation by independent high profile researchers in the field. These names have to be approved by the chairman of the faculty of science appointments committee.

- Once three additional letters are received, the candidate's case can be brought to the faculty appointments committee. The committee's first and foremost purpose it so ensure that the quality of the candidates is high.

- After the candidate is passed through the committee, a job offer (pending approval of the president and rector) can be made. This is when the startup negotiations commence.

Adjunct researchers who have an academic rank equivalent to senior faculty, have to pass the same route as normal hires (in particular, they have to pass through the selection committee and the faculty's hiring committee to ensure the quality). However, they are not part of the short-listing process.

Senior hires at the Full Professor level: Occasionally hires are made at the full professor level (e.g., John Howell and Re'em Sari over the past 20 years). This requires setting up a professional committee, soliciting letters of recommendation and passing both the university committee handling the promotion to full professor (in the experimental sciences) and the committee handling tenure (again, in the experimental sciences). Since the latter often takes longer, the candidate can be offered a position after passing the first committee, but without officially being able to guarantee tenure at that point.

Tenure has to be discussed in the 4th year at the latest, at which point a professional committee has to be established. The dean can then decide to open procedures for promotion, or extend the tenure track position by 2 years. After 2 years, a new professional committee is established and the tenure procedure has to begin with the dean requesting review letters (using a list of suggestions by the professional committee). Once letters arrive, the file is brought to the university's tenure committee. If the candidate does not pass the process, then a termination of employment process is followed. Last time this happened at the RI was in the 1990's. This is because of the significant scrutiny during the hire. In the faculty of science in general, it is not as rare, once every several years, but still uncommon.

Promotion to Associate Professor is discussed in the majority of cases together with the tenure, passing through the same committees. The minority of cases in which tenure is given without promotion are usually experimentalists that took a longer than average time to establish a lab and get their scientific production out. Thus, promotion to associate professor is typically after 6 years.

If promotion to associate professor is not part of the tenure process (but follows), then the promotion procedure can be somewhat shorter in that the professional committee can recommend promotion without soliciting external letters, a recommendation which the dean can accept, and which should be approved by the rector as well.

Promotion to Full Professor requires passing a professional committee, which should recommend promotion. If the dean accepts the recommendation, he or she solicit review letters from high profile researchers from abroad. The file is then brought to the university promotion committee which has to discuss and approve the promotion. Typical promotion to full professor at the RI is 6 years after promotion to associate professor. However, in rare cases it can be a bit shorter, while in a non-negligible number, it is longer, depending on the impact and international stature of the faculty members.

All professional committees require that at least one member be from outside the department (and are typically from outside the university).

5.4.2. Describe how faculty members are informed of these policies and procedures.

Each new faculty member is followed (mentored) by a senior faculty (who is officially appointed to do so). The senior faculty regularly advises the young faculty about what to expect when. In particular, the senior faculty is expected to advise about the requirements for tenure (in terms of publications, grants, teaching etc).

The dept. chair also regularly received from the faculty of science dean's office who are the relevant people that can be considered for promotion or should be considered for tenure. The chairman can then discuss the progress of the faculty with them and inform them of the tenure and promotion procedures.

5.4.3. Specify the policy regarding emeritus faculty activity at the institutional/parent unit/study program level.

There are no strict policies. Emeritus faculty can continue research, apply for grants, and teach (voluntarily). Young emeritii generally do so and are quite active. Older emeritii who decreased their research activity, are occasionally asked to reduce their lab space, or even office space (e.g., share an office with another emeritus professor). This is usually done according to the requirements of the department. As a rule however, the department does not force people to abruptly stop their academic activity.

5.4.4. Specify the steps that are taken to ensure that staff members are academically and professionally updated, with regard to the program, as well as the professional development plan for faculty.

Faculty are regularly updated using e-mail. Important updates and issues requiring discussion are discussed in a yearly, or biannually (depending on the number of issues to be discussed) meeting of all senior faculty of the Racah Institute).

5.4.5. Describe the position of the head of the study program, including the appointment process, term duration, and required credentials (experience and education).

The head of the physics program and the department chair are elected by the aforementioned Racah institute faculty meeting, from candidates that are selected by a search committee of several faculty members (usually previous head of the program and previous chairmen). The term for each position is 3 years, with a possible extension for another one (if the search committee recommends so, and approved by the faculty meeting). These extensions are rare since most if not all faculty prefer research over administration.

5.4.6. List the technical and administrative staff, including the number of staff members and their job descriptions. What kind of support does the technical and administrative staff provide for the academic activity?

The technical staff includes: Computer administration, Machine shop staff, teaching aid staff (in particular, teaching lab managers), technical assistants to experimental researchers. See **attachment 12** for more detail.

Administrative staff include: Main office staff: Administrative manager and secretary. Physics program staff: Senior and regular secretary, research administration aids: 3 secretaries, presently 2 of which are on researchers soft money.

Supporting Documents:

- **Tables 7-12** (Excel appendix).
- Table: emeritus faculty involvement in the program (teaching courses/research/advising graduate students). See **attachment 12**
- Table: The division of faculty members into areas of specialty in the discipline. See **Table 8 & Table 16.**

5.5. Diversity

5.5.1. Specify the institutional and departmental policy and goals regarding diversity of faculty and students (gender and minorities equality).

It is in the department's interest to promote diversity - both reduce the dept gender asymmetry, increase the number of minorities (i.e., Israeli Arabs) as well as members developing townships, without any compromise in the academic level. Besides being the right thing for social equality, encouraging advancement, it has the benefit of tapping presently untapped potential, which could increase the academic level in the department.

5.5.2. Specify the mechanisms and activities supporting the implementation of the policy.

At the faculty level, the main problem in achieving this goal is that the fraction of females amongst the applicants is very low (typically only 10%), while there are virtually no Arab applicants (there has been none over the past 5 years).

To increase the number of female faculty members, several measures are taken.

1. The university requires all members of the selection committee to undergo a small workshop shedding light on unintentional gender biases we may have, so that we may avoid them.
2. The department chair is proactively asking excellent female post-docs to apply. One example for this is an applicant that we ended up offering a position (unfortunately she declined).
3. The department chair and dean actively increase the number of positions to be able to offer suitable females candidates a position when there is a positive fluctuation in the number. Thus, this year we offered two female candidates (unfortunately they declined),

Overall, from 13 job offers we have made over the past 3 years (with N. Shaviv as chair), 3 were to women (i.e., much more than their 10% fraction from the candidates). Unfortunately, only one of the 9 that accepted was female.

Since the largest reduction in the relative number of women is at the PhD to post-doc level (25% to 10%), the main tools in increasing women faculty is encouraging going for a post-doc, which is done at the dept. level through discussions (e.g., a meeting of all the female PhD students with the president's advisor for gender equality), and at the university level, through specialized post-doc fellowships, including a split post-doc partially in Israel and partially abroad, thus solving occasional family relocation complications.

At the graduate level, there are also female and minority specific fellowships.

At the undergraduate level, the university allows more lenient acceptance criteria for students coming from high schools in the Arab, Haredi or social periphery sectors. For the Arab community, there are also special preparatory courses to help their academic integration.

5.5.3. In summary, what are the points of strength and weakness of the issues specified in this chapter?

The mechanisms to encourage a reduction in gender asymmetry are in place, and the department is indeed progressing in the right direction. Unfortunately however, even with all the good will and intentions, it is a long process. With regards to minorities, the situations is less positive given the extremely few faculty candidates out there.

Supporting Documents:

- **Tables 13-14** (Excel appendix).

5.6. Research

5.6.1. Describe how the department's research activities correspond with the institution's overall mission and goals.

The main goals of the department are to be a national leader in basic physics research and education. The research activities are in line with this goal – hire the best possible faculty, carry out the best possible research with the help of the best possible graduate students. High quality research goes hand in hand with the best possible graduate and undergraduate studies.

5.6.2. Specify the department's prominent research areas and uniqueness in research.

The Racah Institute of Physics has several disciplines with very high visibility and impact. Some are "contained" inside the Racah Institute, and some are part of prominent activity taking place at the HU.

Astrophysics is one of the very successful disciplines at the Racah Institute. For many years, the group has numbered 5 faculty members. Although the group has been typically 1/8 to 1/7th of the department, its impact has been much higher. About 1/3 of the papers coming out of the department are from the astrophysics group, half the citations, and until recently, about half the post-docs in the department (recently additional groups have been catching up, so the overall number increased). Although this is partially because of publication "culture" in the discipline, a large part is because the group members have been very successful researchers, raising significant funds (e.g., 3 ERCs, iCore center of excellence) and therefore leading large groups. In fact, the 3 researchers in the department having the highest H-index are all in astrophysics (Dekel, Piran and Sari with numbers around 70-80).

The group however has faced a challenge with its 3 senior members either about to retire (Dekel and Piran) or sadly passed away (Bekenstein, who was about to retire). As a consequence, the group has had to undergo hiring without compromising its level. Another problem has been that historically the group has lacked any observer. This is an anomaly compared with departments outside of the Israel in which there are generally more observational astronomers than theoretical astrophysicists (and a larger fraction of the physics departments in general). Nonetheless, the group has managed to hire the first astronomer (Assaf Horesh) who has the advantage of being an optical astronomer who converted to radio astronomy (in fact, the first and only one in Israel). A second hire has been of a rising star in astronomy, that of the non-Israeli Nick Stone (who did his PhD and post-doc in Harvard and Columbia respectively). Even with these two hires, the group will soon be only 4 non-retired astrophysicists/astronomer. Given how successful the group has been, one should strive to increase the group (as also suggested in the previous decadal report).

Another recent success is the group's attempt to develop observational astrophysics is establishing (mostly with a donation) a half meter telescope observatory that would serve a triple purpose - outreach (luring kids into physics and astronomy), advanced student lab (luring students into astrophysics and astronomy) and carrying out state of the art transient astronomy (requiring fast agile automatic telescopes).

The **Biological Physics** group was established at the Racah Institute in 2003. The field is an emerging discipline mostly driven by experimental work. Between 2003 and 2012, two more experimental groups were established in two major additional sub-fields of Biological Physics, bacterial chemotaxis and single molecule measurements in live mammalian cells. Today, the group comprises 3 experimental groups and a joint appointment with the Brain Center of a theorist in neuroscience. The group has already established itself as a leading group in Biological Physics, with numerous publications in high impact journals from the three labs (Nature, Science, Nature Communications, PNAS, etc.) as well as two ERC grants.

Although the main effort in Biological Physics is on the experimental side and theory is done within the experimental groups, at this point it is clear that the deep understanding that we are used to from Physics cannot be attained without developing the theory side. Therefore, the Biological Physics group is putting efforts in recruiting a leading theorist in the field.

Related activity is that of Brain Research and in particular computational neutral networks. The discipline that started by physicists at the RI (by Haim Sompolinsky, Hanoch Gutfreund and Daniel Amit), has grown and takes place in the brain research center, with several physicist as members members.

The **condensed-matter group** at the Racah Institute is involved in a wide range of research activities. On the experimental side these span topics such as van-der-Waals devices, superconductivity, light-matter interaction, physics on the nano scale and electronic glasses, using a variety of experimental techniques from transport measurements to various surface probes. Much of the activity on the theoretical side is concerned with strongly correlated electronic systems, superconductivity and, more recently, topological phases of matter and applications of advanced numerical techniques.

The group has a significant number of young faculty, with three experimental recruitments (Steinberg, Bar-Gill and Anahory) and three theoretical recruitments (Khodas, Ringel and Gazit) over the past five years. It enjoys a warm atmosphere that leads to a number of collaborations among its members. There is emphasis on high quality teaching and mentoring of graduate students. The group is also very successful in obtaining competitive funding, including four ERC starting grants (Katz, Bar-Gill, Steinberg and Anahory).

The bibliometric performance of the group has improved in recent years, especially on the experimental side, but is still wanting. Our hope is, and there are already signs to this effect, that the new faculty members will improve the figures and correspondingly the group's visibility. While some of the graduate students involved in condensed-matter projects are excellent, many researchers find it difficult to recruit good students. A significant number of the best undergraduate students leave at the end of their first degree (especially to the Weizmann Institute) or join other groups. Historically, there was also a great difficulty in recruiting good postdoctoral fellows. The situation has improved over the last few years, especially in terms of experimental fellows, but there is still a need to increase the number of theoretical postdocs. Finally, while the startup processes of Hadar Steinberg and Nir Bar-Gill can be characterized as successful, the construction of Yonathan Anahory's lab is only now being finally constructed – over two years after his arrival to the Racah Institute (mainly because it was discovered that the light rail will be passing close to the planned lab location). In addition, alongside excellent fabrication and characterization facilities at the nano center, various aspects of the experimental supporting infrastructure still required improvements, e.g., the electronics workshop and the number of staff technicians.

High Energy physics has traditionally been strong at the Racah Institute, in particular, theoretical aspects such as string theory. Until recently, the active members included Amit Giveon and Barak Kol, with Eliezer Rabinovici and Shmuel Elitzur being active emeriti. Rabinovici is now the vice president of the council of CERN and has been instrumental in the establishment of the Sesame – the middle eastern synchrotron facility—the only place were Israelis and Iranians sit around the same table regularly. Given however the retirements, a new high energy theorist, Michael Smolkin, was hired.

However, one aspect of high energy which has always been missing is that of high energy phenomenology. Despite several attempts, it is only very recently with the hires of Yonit Hochberg and Eric Kuflik that this has completely changed. The two new faculty had 6 separate grants and 2 post-docs from day one, turning HEP from non-existant to very active. Nonetheless, a third sub discipline, that of experimental high energy is completely missing.

It should also be noted that the group regularly enjoys very high profile visitors due to the regular high energy schools at the Institute for Advanced Studies (run by David Gross). David Kutasov is another long term visitor spending 3 months a year at the RI.

The **nonlinear physics** group consists of 5 theoreticians and 2 experimentalists. Originally focused on nonlinear physics, the activity in the group currently covers the fields of soft matter physics, out of equilibrium statistical mechanics, materials science and solid mechanics. The group publishes in high profile journals: In the last 10 years, out of 200 publications, there were 4 publications in Nature/Science, 9 in Nature subsidiaries and 39 in PRL. Many of the former students of the group have tenure track position. Over the past decade, 6 found in Israel, 3 in the USA, while 4 former post docs have tenure track positions either in Europe (2) or Israel (2). Some members of the group are excellent teachers such that every year a few find themselves on the rector's list of outstanding lecturers.

Out of the 7 members of the group, one has retired in 2017 (Friedland), and two retirements are expected in 2019 (Meerson) and 2022 (Fineberg). One member joined us in 2018. Given the strength of the group on one hand and the immanent retirements on the other, two hires of an experimentalist and a theoretician are required. As the “group” covers a growing range of topics, we believe the future hiring in statistical mechanics and in experimental soft matter physics will be under the responsibility of the group. As the Racah institute is spread over several buildings it is not easy to manage this hiring plan, keeping the “geographical integrity” of the group. However, our experience shows the importance of this integrity, mainly for our students and post docs. This point is a main concern of ours.

Another aspect to increase the strength and visibility of the group is to increase the coverage of the field in the undergraduate studies curriculum, planning to add courses in soft matter physics and nonlinear dynamics/pattern formation.

Nuclear Physics was historically from the days of Racah, one of the strong disciplines in the department. However, changing fashions and retirements lead to a steady decline both at the HU and elsewhere. Recently, however, there has been a significant resurgence and renewed interest. Basic research in nuclear physics has advanced significantly in recent years and now spans a wide range of topic in modern physics. Among these current issues are: the study of nuclei far from stability, the strong nuclear force and the formation of quark gluon plasma in the moments after the big bang, the study of stellar nucleosynthesis, the study of the structure of hadrons, and the search for beyond standard model physics using precision measurements. Nuclear physics impacts not only basic research but contributed greatly to modern society via nuclear medicine (both diagnostic and treatment), energy production, radiation safety, and dating for archeology and art.

The Racah Institute currently numbers two active faculty members in nuclear physics, one experimental and one in theory. The group is involved in several high profile experiments, taking place in international labs and leading large, international, collaborations. A recent success is the construction of a new lab building at the Soreq Applied Research Accelerator Facility (SARAF) which was mostly funded by the Israeli Atomic Energy Committee, and houses the HUJI NP labs. While together with several emeriti professors, the scope of research performed spans a significant fraction of modern nuclear physics, this situation in not sustainable in the long term. A recent report by the national committee on nuclear physics (appointed by the Israeli Academy of Science) found that there is an urgent need to hire additional faculty members in the field and recommended a series of actions designed to encourage such hires (see supplementary material). Of these steps, the dedicated funding for new faculty hires, was not implemented by the Israeli council for higher education. Although NP activity is now on the rise, this will continue only if the group will not be allowed to decrease again.

Quantum Information and related topics is an example of a field that thrives through interdisciplinary interaction at the university, supported by super-critical activity. The Quantum Information Science Center of the Hebrew University (see: qcent.huji.ac.il) is one of the strongest centers of the Hebrew University. Founded in 2011, it is led by Prof. Nadav Katz (Physics). The center incorporates 27 research groups, spanning Physics, Mathematics, Engineering, Computer Science, Chemistry and Philosophy.

The Physics groups within the center are: Bar Gill (joint with Engineering), Biham, Bromberg, Eisenberg, Howell, Katz, Gat, Rapaport (joint with Engineering), Ron and Steinberg.

The center has generated a thriving culture of collaboration and connectivity within the university, leading to many joint publications. It also supports several international conferences and workshops yearly to coordinate and facilitate international connections. Especially strong are our connections with the quantum center in Ulm/Stuttgart. This includes also a membership in the Alliance for Quantum Innovation, in which we have several funded projects.

The center is also leading the national quantum communications demonstrator (a 7.5 million NIS project), awarded in 2017, with 7 HUJI PIs leading the project along with industry partners. The center is also looking to accelerate quantum technology innovation, spinning off from our PI's work, with several startups already funded. We are now also organizing the first Israeli quantum tech conference, see: https://events.bizzabo.com/futureofquantumtech/home

Many of the quantum center's members have won prestigious awards and highly competitive grants (such as the ERC grants).

We submitted an ambitious growth program to the PBC (Planning and Budgeting Committee of Israel), and require significant new experimental and manpower infrastructure to support this. Meanwhile, the center has begun funding a new and advanced electronics workshop infrastructure and hope to be able to join forces with the HUJI nanocenter to provide further state-of-the-art support the experiments.

See also the brief presentation of the center, its excellence/awards, recent publications and future plans in the additional information folder.

The **nano center** (http://www.nano.huji.ac.il) is another interdisciplinary center bringing together researchers from different fields, including physics, while providing a conducive environment and infrastructure.

5.6.3. Specify the intellectual property policy of the institution in relation to the department.

The university has clear guidelines regarding the commercialization of IP. Any IP developed as part of university research by default has to be commercialized through the Yissum subsidiary of the HU. (Having a subsidiary is required by state regulations of the higher education). However, ownership of IP is split between the university and researcher (or research group), with the exact percentage depending on whether part of the IP goes to the research lab. Thus, researchers have an incentive to develop IP, as does the university. Yissum is responsible for patent filing and maintenance, as well as raising capital and developing the commercialization. Presently there is one company at an advanced stage which is developing laser based acceleration (e.g. for proton therapy), and which is based on Racah IP. A few more are at their initial stages.

5.6.4. Describe the commercialization unit of the institution, its function, number of patents registered, and where have they been registered.

See previous item. Also, the table below presents the yearly number of patents coming out from the Racah Institute and compared with Applied Physics, which is an engineering department.

	2014	2015	2016	2017	2018
Physics	0	2	4	3	4
Applied Physics	3	7	7	6	6

5.6.5. Specify the journal ranking the department relates to when evaluating faculty publications. If the department or institution has its own scale (not international) or another method for evaluating (e.g. peer review), provide a brief description and the ranking list.

The Hebrew university used to have a HU index of journals, but it has phased out (at least in the sciences). In physics however, there is a clear correlation between what is considered a good venue for publications and the citation impact of the journal. Thus, there are the top general physics journals (PRL, nature, science), there are top journals in each discipline (e.g., Astrophysical J., Monthly Notices and a couple more in Astrophysics), while the rest are mostly judged based on their citation impact.

5.6.6. In summary, what are the points of strength and weakness of the issues specified in this chapter?

Given its size of about 40 faculty members, not all physics sub-disciplines can be represented. Nonetheless, those disciplines that are represented are generally very active and doing well. Having said that, a few disciplines are at a precarious state given recent and imminent retirements.

Supporting Documents:

- **Tables 15-16** (Excel appendix).

- List: cooperation activities by department members both in Israel and abroad (last 5 years). – *This is too much ill-defined information which we don't have.*
- List: research infrastructure of the faculty: research laboratories, research centers, specialized equipment and budget for maintenance (level and sources of funding). – See **Attachment 13**

5.7. Infrastructure

5.7.1. List the campuses on which the study program is taught. If the study program is offered on more than one campus, is the study program identical on all campuses? What measures are taken to ensure this?

All the studies are given at the Safra – Giv'at Ram Campus. The exceptions are the "Corner Stone" program courses (physics for non-science majors) given in Mt. Scopus.

5.7.2. Specify the department's physical location in the institution (building/s). List any other departments that share the building/s.

Due to historic reasons, the physics department is spread over quite a few buildings:

	Admin	**Research**	**Teaching**	**Meeting / seminars**	**Notes**
		Physics Buildings (or part of buildings)			
Levin	Main & program offices	Research Labs, offices	Main Lecture Hall	Meeting room	Hosts machine shop
Kaplun	Research Secretary	Research Labs, offices		Seminar Room	
Danciger B	Research Secretary	Research Labs, offices		Seminar Room	
Marx		2 exp. groups			Shared with a spinoff company
Ross	Research Secretary	Offices, 1 lab + reserve		2 seminar rooms	Shared with math
Popick		Offices			
Bergmann		1.25 expr groups			Rest is applied physics
Daroff		1 research lab			
		Shared Teaching (Run by the faculty of science)			
Bitan 9			Teaching labs & offices		
Brandman		2 research groups	Teaching labs & offices		
Feldman			2 Lect halls + demo lab		
Sprinzak			Teaching classes		
Kaplan			2 Lect halls		

5.7.3. List the physical infrastructure that serves the department. Refer to classrooms, computerization, administrative and academic faculty offices; to what extent does this infrastructure enable the department to operate according to the defined aims and goals?

Classrooms: Lecture halls and classrooms used for teaching are handled jointly by the faculty of science and school of engineering, as the large halls on campus and classroom building (Sprinzak) are shared. There is some shortage in large halls because computer science has significantly expanded over the past few years with each cohort being much larger than before.

Seminar Rooms: There used to be a shortage of seminar / interaction rooms at the RI, but with recent renovations of Ross building, two new seminar rooms were added.

Administration offices: There is presently no shortage in administration offices, just administrators.

Faculty offices: With the recent expansion of the department, the number of faculty reached the number we had around 20 years ago. However, today emeriti are more active and for more years than that past. Also, the number of post-docs increased significantly. 20 years ago, there were only 5-10 post-docs. Today there are almost 30 in the department. Since they typically take half the office space of a faculty, we're running close to full capacity.

Lab space: Again, compared with 20 years ago, we have almost the same number experimentalists. However, a few labs of particularly productive emeriti are still active. Also, the typical floor space occupied by a lab today is about 20% larger than 2-3 decades ago. As a consequence, we have reserve floor space for about 1 or 2 labs (and even that in Ross' limited basement, as it is close to the planned path of the light rail, where 8000 Amp currents are expected).

Presently the infrastructure is used at about full capacity. This means that future expansion through absorption of new faculty is going to be constrained by available infrastructure. This is also true to any possible increase in student enrollment. Present teaching labs are used at their fullest capacity (see sub-section below).

Another problem with the infrastructure is that some of it is old. Besides the esthetic implications (which can reflect bad on visitors and prospective students), it also implies that renovations such as those associated with new office space or new labs is typically very expensive. Poor maintenance and poor daily cleaning is another problem.

The last problematic aspect of the infrastructure is that it is spread over a countless number of buildings. This makes it hard to form a cohesive department. It also makes it hard to plan ahead given that the number of faculty in different disciplines is not known accurately in advance. As a consequence, some of the groups are spread over more than one building.

5.7.4. List the laboratories that serve the department (users, equipment, and number of seats).

See **attachment 13** which lists the available equipment available for research.

In terms of teaching labs, there are 60 student seats in the first year lab, 62 student seats in the 2nd year lab, and 20 student seats in the 3rd year lab.

5.7.5. List special equipment and other relevant materials to this section.

See **attachment 13**, listing the special equipment available.

5.7.6. Describe the library including computerized databases which serve the students, and teaching staff of the study program.

The faculty of science has a large library, with subscription to almost all the important journals (but typically somewhat less than top US universities). They also have course text books that allow students to loan books a couple of times a semester in major course. The book collection as is the printed journal collection, are less extensive, but this is expected as we become progressively more digital.

5.7.7. National Infrastructure:

5.7.7.1. Is there a need for facilities that can serve the evaluated field on a national level, such as unique labs, research centers, libraries etc.? If so, specify the need and the added value for their development on a national level.

There is currently no national supercomputing center in Isreal. The Inter University Computing Center (IUCC - "machba") used to provide some supercomputing services, but they phased out and switched to being front ends of commercial cloud computing. The Israeli Science Foundation which funds significant personal clusters should consider funding a national center, in addition (and partially instead) of funding personal hardware. This could prove to be more cost effective, and allow more researchers access to CPU intensive computing.

5.7.7.2. Operating national infrastructures: how accessible are the services (prices, enrolment, usage, etc.)?

The only national level infrastructure used by researchers in the department is the Soreq Applied Research Accelerator Facility (SARAF). It is a proton/deuteron RF superconducting linear accelerator, with variable energy (5-40 MeV) providing a platform for experiments in Nuclear Physics. It is readily accessible to RI nuclear physicists.

5.7.8. In summary, what are the points of strength and weakness of the issues specified in this chapter?

Perhaps the most acute infrastructure problem that the RI has, is its spread over numerous building, and the fact that most of these building have poor infrastructure.

On the other hand, the research facilities available for researchers (equipment in the nano-center, 3D printing, fine machine shop, electronics lab), are mostly very good or in the process of getting better.

5.8. Ultra-Orthodox Study Program

There is no Ultra-Orthodox study program in physics.

Additional Required Materials

In the “Additional Required Materials” folder, please find:

- Detailed course syllabi
- CV of faculty members
- Same exams (Note that due to technical limitations of the exam online scanned exam service, there are sample solved exams only from the 2nd semester)
- Sample Master and PhD theses.
- Additional Information