



EVALUATION OF PHYSICS AT BAR-ILAN UNIVERSITY

COMMITTEE FOR THE EVALUATION OF PHYSICS DEPARTMENTS IN ISRAEL

AUGUST 2019

Section 1: Background and Procedures

1.1 In the academic year 2018-19 the Council for Higher Education [CHE] put in place arrangements for the evaluation of study programs in the field of Physics in Israel.

1.2 The Higher Education Institutions [HEIs] participating in the evaluation process were:

- Ariel University
- Bar-Ilan University
- Ben-Gurion University
- The Hebrew University
- Lev Academic Institute
- The Open University
- Technion – Israel Institute of Technology
- Tel Aviv University
- Weizmann Institute of Science

1.3 To undertake the evaluation, the Vice Chair of the CHE appointed a Committee consisting of¹:

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| • Prof. Steven Kahn: Committee Chair | Stanford University, USA |
| • Prof. Laura Greene | National MagLab and Florida State University, USA |
| • Prof. Herbert Levine | Northeastern University, USA |
| • Prof. Michal Lipson | Columbia University, USA |
| • Prof. Yael Shadmi | Technion, Israel |

Ms. Maria Levinson-Or served as the Coordinator of the Committee on behalf of the CHE.

1.4 The evaluation process was conducted in accordance with the CHE's Guidelines for Self-Evaluation (February 2018). Within this framework the evaluation committee was required to:

- examine the self-evaluation reports submitted by the institutions that provide study **programs in Physics**
 - conduct on-site visits at those institutions participating in the evaluation process
 - submit to the CHE an individual report on each of the academic units and study programs participating in the evaluation
 - set out the committee's findings and recommendations for each study program
 - submit to the CHE a general report regarding the evaluated field of study within the Israeli system of higher education

¹ The committee's letter of appointment is attached as **Appendix 1**.

- 1.5 The evaluation committee examined only the evidence provided by each participating institution — considering this alongside the distinctive mission set out by each institution in terms of its own aims and objectives. This material was further elaborated and explained in discussions with senior management, faculty members, students and alumni during the course of each one-day visit to each of the institutions.²
- 1.6 This report deals with the Department of Physics at **Bar-Ilan University**. The Committee's visit to Bar-Ilan University took place on June 12th 2019. The schedule of the visit is attached as **Appendix 2**.
- 1.7 The Committee would like to thank the management of Bar-Ilan University and the Physics Department for their self-evaluation report and for their hospitality towards the Committee during its visit to the institution.

Section 2: Executive Summary

Bar-Ilan University (BIU) has grown rapidly over the last four decades to emerge as one of the leading research universities in Israel. With its historical emphasis on Jewish studies, and its comparatively conservative culture, BIU has had a particular appeal to religiously-minded students and faculty, both Jewish and Arab. The Physics Department at BIU has made a strategic decision to restrict its attention to particular fields, primarily condensed matter, statistical physics, and biophysics, which has enabled it to compete effectively with other Israeli universities in these areas. More recently, it has chosen to expand into astrophysics, making two faculty appointments in that field.

The undergraduate and graduate programs in physics at BIU are functioning well. The department has created a unique program for gifted high school students, enabling them to take courses in physics and math while still in the 11th and 12th grades, and then completing their degrees in one year afterward. They have also established a cooperative program with Shandong University in China, which has brought a number of Chinese students to the Ramat Gan campus for both undergraduate and graduate studies in physics. Students in physics at BIU are generally happy, partly due to the efforts of the Deputy Department Head, who has done an excellent job overseeing both curricular and student welfare in the department. Our strongest recommendation is for the department to ensure that this individual is retained and happy, given his key role, and to consider succession planning for this position in the future.

² Prof. Yael Shadmi did not participate in the visits to the Technion and to Ariel University or in the panel's discussions concerning the evaluation of these institutions; Prof. Herbert Levine did not participate in the visit to Bar-Ilan or in the panel's discussions concerning the evaluation of this institution; Prof. Michal Lipson did not participate in the visits to Weizmann Institute of Science, Bar-Ilan University, Jerusalem College of Technology, Ariel University and Ben-Gurion University.

Other recommendations include looking into providing visitor space in the department as well as facilities for hosting workshops and conferences on campus, improving the diversity of the faculty, and continued monitoring of the exchange program with Shandong to ensure that the students involved are well-served. In terms of the research program, we advocate expanding the fledgling astrophysics effort to ensure critical mass, and consideration of additional expansion into particle physics.

Section 3: Observations

3.1 Introduction

Established in the late 1950's, BIU has grown into one of the leading universities in Israel, with forefront programs in both humanities and science, as well as in professional disciplines. The institution has expanded aggressively in a number of areas in recent years. Through its emphasis on Jewish studies, BIU has had a special appeal to religiously minded faculty and students, that has also attracted a larger than average fraction of Arab students. The Department of Physics has a distinguished history. In contrast to some of the other universities, it has concentrated its efforts in condensed matter physics, optics, biophysics, and statistical physics, where it has made major achievements. There has also been a very recent expansion into astrophysics.

3.2 Organizational Structure

The primary BIU campus is in Ramat Gan, where its Department of Physics is located. Within the University, the organizational structure follows standard format. The Physics Department is in the Faculty of Exact Sciences, and the Dean reports to the Rector. There is no significant substructure within the Physics Department.

3.3 Self-Evaluation and QA

The Self-Evaluation process began in the office of the Deputy Rector, which provided the overall coordination. The Physics Department Head, Professor Lior Klein, commented that the collaboration between the department, the faculty and the deputy Rector's office was excellent, and made it much easier for him to write the report.

The Physics Self-Evaluation report was written almost entirely by Prof. Klein, working closely with the Deputy Head of the department, Dr. Yossi Ben-Zion, and the coordinator of the department, Rita Dodiomov. Initial drafts, generated by Ben-Zion were transferred to relevant faculty members for comments and additions, followed by a final proofreading by Klein and by Prof. David Kessler.

The self-evaluation of research was conducted by asking each faculty member to write-up his or her own evaluation, emphasizing the research area, overview of recent activity, impact, future plans for development, and challenges. Each summary was approved by Ben-Zion, Klein, the Dean, and Dodiomov.

3.4 Undergraduate Education

BIU offers a single undergraduate physics degree, as well as many joint degrees. The program is flexible, and students can choose to do a dual major with physics plus any other subject. A BSc in computational physics, with a quantum computation component, will be added next year.

The admission threshold for the single physics degree is relatively low, and the dropout rate after the first year, is correspondingly high, roughly 20%. The department has looked into possible correlations between students' success in the program, and their application criteria (matriculation and psychometric grades), and found none.

Teaching is mostly via traditional lecture at the blackboard. The department recently started to videotape lectures, and now some videos, as well as other online materials, are available for some courses.

The Deputy Head of the department, Dr. Ben-Zion, coordinates the teaching program and handles most student issues. He has recently initiated a MOOC program, in collaboration with an Arab graduate student, to create a course in mechanics, taught in both Hebrew and Arabic. We were told this was very successful, and there are many subscribers to the Arabic course. Since some international students are taking the 3rd year courses, these are now taught in English. Most Israeli students prefer this, since they would like to improve their English proficiency. Due to the size and focus of the department, elective course offerings are somewhat limited. Teaching particle physics, which is not represented among the faculty, is particularly challenging, and the department relies on outside lecturers for this elective.

Students are encouraged to engage in research as early as in the 1st year. Research opportunities are exposed to the students through a seminar course, in which faculty present their research, as well as through the 3rd year lab, which encourages independent projects.

The university and the department have several outreach programs in place, and these, coupled with the introduction of dual degrees, have contributed to the recent ~50% rise in enrollment. A major initiative has been the BIU High School Program, which allows gifted high school students to study towards the bachelor's degree during 11th and 12th grades, and to complete their degree the

following year. Another program enables such students to participate in summer research projects. While these programs appear to have been quite effective in attracting students, we have some concerns about them. In particular, they have the effect of channeling gifted students Israel-wide into the particular physics program at BIU, rather than into the full suite of major universities in Israel which offer physics degrees. Since the physics research effort at BIU is markedly narrower than that at the other universities, this limits the exposure of these young gifted students to the full scope of physics that they might be interested in pursuing. The program also seems to draw primarily from the center of Israel, so it has not played a significant role in attracting students that may be quite talented, but have had weaker preparation, such as those from the periphery.

Another major outreach element has been the department's affiliation with Shandong University in China, which has a special college for excellent students, and which has been identified by BIU as a good partner for its undergraduate program. Several top students from Shandong now come to BIU for their 3rd year, taking the courses in English, and engaging in research with BIU faculty. This pilot program has been very successful, and so far, all five students who came here last year stayed on for an MSc. The program will be expanded starting next year, with students getting a joint BIU-Shandong degree.

3.5 Graduate Education

BIU offers an MSc program in Physics, as well as in Nano-Technology and in Biophysics, both of which have physics components. The structure of the graduate programs is similar to that at the other Israeli research universities, where students engage primarily in coursework in their first year and perform a research project in their second year. A large fraction of their students, and most of their best graduate students, were previously BSc students at BIU, and have had the opportunity to engage with research groups before formally starting their graduate studies.

The PhD program is also fairly standard, and primarily involves independent research work culminating in a PhD thesis. As at other universities, there is an opportunity to follow a Direct PhD track, where students skip the masters' thesis and proceed directly into the PhD program, shortening their stay by 6 months to one year. We comment on the Direct PhD alternative in the general section of this report.

Financial support for graduate students, comprised of fellowship, research, and TA components, appears adequate, and is competitive with that offered at other universities. However, international students cannot TA, and as a result the

stipend of the Shandong graduate students is unusually low, which is barely enough to survive on.

Graduate advising comes primarily from the thesis advisor, and the department does not make exceptional efforts to monitor student progress after submission of the research proposal and before completion of the thesis. However, we did not hear of any major problems on this front. This is partly because of the outstanding efforts of the Deputy Head of the department, Dr. Ben-Zion, who provides the primary source of advice for both undergrads and grad students on topics ranging from course selection to career counseling.

3.6 Faculty and Human Resources

BIU is unique among Israeli physics departments in terms of its strategy of covering only specific research areas in which they can excel. National initiatives, such as the new quantum science effort, are important catalysts in shaping hiring policy. Thus, there was no HEP or astrophysics research in the department until recently, when the department decided to branch into astrophysics, and the first astrophysicist was hired last year. In reality, hiring involves a combination of a guiding strategy and natural developments, dictated by the limited pool of candidates.

The hiring of new faculty is handled through a screening committee, with representatives from different areas, that looks at a variety of candidates from a department-level perspective. As at other universities in Israel, the basic paradigm is to look primarily at Israelis returning from a postdoc abroad.

There are two full-time teaching faculty. One is in charge of the lab program, and the other is Dr. Ben-Zion, who is in charge of all other aspects of teaching and advising students, and who has been instrumental in improving the teaching program and the students' experience. Since these are not regular faculty positions, with no research component and no influence over general departmental policy, there is some risk of frustration in these jobs. Another potential problem is the relegation of virtually all curricular and student issues to non-research faculty.

Research labs have lab technicians, who are really researchers. Most of them are permanent employees, and 50% of their salaries are funded by the university. As at other universities, this system has its drawbacks, although it seems to be working better at BIU than elsewhere. We comment on these positions in the general report.

3.7 Research

Optics

Research in optics-related physics at BIU involves a number of faculty (Pe'er, Sebbah, Shwartz, Taitelbaum, Weiss), and has a distinguished history. Topics of investigation include: random lasers, light propagation in highly scattered tissue for cancer diagnosis and therapy, development of inorganic nanoparticle voltage sensors for probing neural networks, a super-resolution imaging method dubbed SOFI, and novel optical imaging tools for single cell physiology. The faculty is especially known for studying wave propagation in complex media, and many of the activities are centered on imaging in biological media, including novel techniques to overcome light scattering in biological tissue, biological markers for deep brain stimulation and detection, etc. Papers have been published in top scientific journals and have been highly cited. Research in quantum optics, led by Pe'er, includes quantum optics precision measurement and control of light-matter interaction, and topological lasers. This work is well known in the scientific community.

Astrophysics

There is strong student interest in astrophysics at BIU, and the department made a conscious decision to expand into that field nine years ago. While it took some time to successfully recruit appropriate faculty, the program is off the ground with the hiring of Asaf Peer, who is on campus now, and Ofek Birnholtz, who will arrive in the Fall. Peer is a theoretical high energy astrophysicist, who has worked on gamma-ray burst modeling, among other topics. Birnholtz is a relativist and theoretical astrophysicist, who has become engaged in LIGO, and will be the first to bring that expertise back to Israel.

It is too soon to tell how the astrophysics research effort will evolve at BIU, but these appear to be two excellent appointments, so they are off to a good start.

Condensed Matter

Experimental condensed matter physics (Frydman, Kalisky, Klein, Sharoni, Shlimak, Stern, and Yeshurun) is well supported through the Nano-center, which is an impressive facility. Areas of research include nanoscience, disordered metals, the interplay of superconductivity and magnetism, magnetic materials, correlated electron materials, spintronics, and the anomalous Hall Effect. Faculty members employ a range of novel techniques. Scanning SQUID microscopy, which is a highly sensitive local magnetic scanning technique, is used to map out interesting metallic, magnetic, and correlated electron phases. Other scanning probe techniques such as scanning transmission electron microscopy are also

being used. They have excellent nanofabrication facilities and BIU has the only Rutherford backscattering user facility in Israel. There is also research on superconducting qubits for quantum computing in the Nano-center.

Theoretical condensed matter physics (Berkovits, Dalla Torre, Feigel, Gutman, Kogan, Shapiro, Shimshoni, Ruhman) is extremely broad, covering a wide range of areas including many-particle quantum systems, quantum phase transitions, quantum computing, correlated electron materials, several areas in superconductivity including vortex dynamics, magnetism, topological materials, graphene, the quantum Hall effect and Kondo materials. There is a great deal of cross-collaboration in this group, and the faculty members share postdocs, showing how friendly and supportive they are of one another.

The Committee felt that the experimental and theoretical condensed matter physics area was, in general, of very high quality.

Biological and Statistical Physics

The experimental biophysics group at BIU is strong, and there is a significant interest in biological systems among many of the members of the statistical physics group. Yuval Garini has emerged as a leader in applying advanced imaging methods to a variety of important biological problems. Other labs (Deutsch, Roker and part of the Kalisky group) study systems ranging from biomolecules to individual cells, with a specific focus on molecular scale processes.

On the theory side, there is a large and distinguished group of statistical physicists. The most well-known is Shlomo Havlin, winner of the Israel prize, the Weizmann prize, and the APS Lilienfeld prize for his pioneering contributions to network science, both in living and nonliving systems. Bartsch is a junior faculty member who also investigates network science applications. Barkai, Kessler, Shnerb, and Rabin are strong investigators who use the theory of stochastic processes to investigate biomolecules, particles moving inside cells, and ecological and/or evolutionary dynamics.

Other members of the statistical physics group (theorists Rappaport, Teitelbaum and Dana; and experimentalists Sheebah and Sloutskin) study a variety of interesting soft-matter systems. BIU's decision to concentrate effort on this research area has yielded very impressive results.

3.8 Students and Alumni

Students

Undergraduate students are generally satisfied with their experience at BIU. Faculty members are approachable and helpful, and students feel supported and encouraged. The students seem to be a cohesive and cooperative group, with the senior students helping "younger" students. There is a social event every semester.

The university has a mentorship program for excellent students, but a structured, formal program does not exist for all students in the department. Still, the Deputy Head of the Department, Dr. Ben-Zion, is available for questions and advice, and holds a meeting for 3rd year students to explain graduate school options.

BIU enrolls a larger than usual number of international students because of its connection to Shandong University. Classes are taught in English for these students, but there are still challenges to fully integrating them into the student body, because of the cultural differences. The primary concerns of the foreign students involved finding adequate housing, but that situation has improved recently. Based on our limited interviews, there seems to be little interaction between the Chinese students and the Israeli students.

Graduate students choose to attend this university or choose to stay on after completing their bachelors there, primarily because of the quality of the faculty, and their interest in the research programs that BIU has to offer.

Alumni

The alumni we met all work in industry and got their PhDs at BIU. They feel that their education, which stressed freedom and independence, coupled with good advising, has taught them how to think and made them versatile. They felt that the addition of a few non-physics courses could have improved their preparation for careers in industry: project management, coding using current programming languages, and a course on delivering presentations are some examples. They did have the opportunity to present their research to non-physicists in the Nano-center, which was a useful experience.

The atmosphere in the department was friendly and supportive, with a high level of commitment towards the students, as well as flexibility, where needed.

There was no institutional help with finding jobs outside academia, and there was some pressure on good people to continue in academia. Still, individual

advisors have been helpful in connecting with industry and finding their students a first job.

3.9 Infrastructure

Research labs: Some of the research labs are located in the new Nano-center, which provides a lot of space for interactions in addition to lab spaces. The lab spaces are uniform, with offices for the PI, students and postdocs adjacent to the actual lab. The labs are well equipped with state-of-the-art equipment. We were not exposed to research labs in the main physics building, where conditions may not be quite so favorable.

Teaching labs: Some of the lab equipment is dated, and the beginning labs are fairly "cookbook". The 3rd year optics lab is more open ended.

In the view of the physics department, the university has inadequate facilities for hosting and organizing conferences, and there is no visitor space in the department, which limits interactions with outside physicists.

3.10 Diversity

The fraction of female students majoring in physics has increased recently to around 30%. However, there are only two women on the physics faculty out of 34. In our meeting with senior university management, it was stated that they could not find excellent women to hire as faculty.

About one third of the students across the university are Arab. This was claimed to be the highest fraction in Israel, and the university has indeed taken some positive steps to increase the number, including providing prayer rooms for Muslim men and women on campus. While Jewish students are required to take courses in Jewish Studies, Arab students are exempted from this requirement, but some take the courses anyway out of interest. The more conservative nature of BIU, associated with its emphasis on Jewish studies, appears to appeal to select groups of both Jewish and Arab students.

BIU reaches out to the Ultra-Orthodox population and has a designated preparatory program for such students. There is also a separate building on campus, in which they take their classes. BIU has about 200 Ultra-Orthodox students, but it is unclear if any are enrolled in the physics program.

The BIU exchange program with Shandong University has increased the international diversity of the undergraduate and graduate students. The program is too new to determine if it will have an effect of diversifying the PhD student population.

Section 4: Recommendations

Essential:

- **Pay attention to succession planning for the Deputy Department Head.** Dr. Yossi Ben-Zion is playing a very key role in the physics department at BIU, in a number of respects. We consider it a risk that such a key role is tied to a member of the teaching faculty, as opposed to the research faculty, but Dr. Ben-Zion is eminently qualified nonetheless. Every effort should be made to ensure that he remains happy in this role. Even though he is not close to retirement, succession planning should be considered for this position, as it is rare to find such responsibility concentrated in a single individual.

Important:

- **Identify suitable visitor space to enhance interactions with outside researchers.** At least one or two offices should be identified and made available for visitors in the main physics building. This is key to ensuring that the department can benefit from increased interactions with external colleagues. In addition, the university should look into ensuring that there are adequate spaces on campus for hosting workshops and conferences.
- **Reevaluate the health of the exchange program with Shandong, at both the undergraduate and graduate levels.** This program does seem to be working, although the level of interaction between the Shandong students and Israeli students does not seem to be extensive. Take steps to ensure that the Shandong students remain happy with their experience at BIU. Look into the financial support provided to graduate Shandong graduate students given their inability to hold TAs.
- **Take more proactive steps to increase the gender and ethnic diversity of the faculty.** While the gender representation among the students appears reasonable, there are still very few women on the faculty. The lack of suitable women candidates is not an acceptable rationale for this situation. The department should be more proactive in its recruitment of women. To our knowledge, there are no Arab members of the physics faculty. Here too, extra effort should be made to identify and recruit outstanding Arab candidates.


Advisable:

- **Continue to monitor the success of the fledgling astrophysics program.** The department has made excellent initial appointments in this area, but

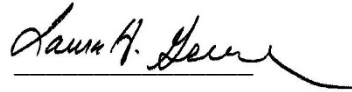
nevertheless close attention should be paid to ensure continued success. The current effort is below critical mass, and it must be expanded to remain viable.

- **Consider an expansion into particle physics.** Particle physics is a major component of physics as a whole, and the lack of particle physics at BIU is conspicuous in comparison to the other Israeli universities. At present, particle physics elective courses must be taught by outsiders. Expansion into this area will require careful thought and planning, but it should be possible.

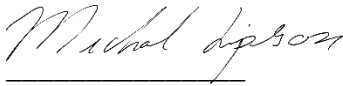
Signed by:



Prof. Steven Kahn
Committee Chair



Prof. Laura Greene



Prof. Michal Lipson



Prof. Yael Shadmi

Appendix 1: Letter of Appointment



December 2018

Prof. Steven Kahn
Department of Physics
Stanford University
USA

Dear Professor,

The Israeli Council for Higher Education (CHE) strives to ensure the continuing excellence and quality of Israeli higher education through a systematic evaluation process. By engaging upon this mission, the CHE seeks: to enhance and ensure the quality of academic studies, to provide the public with information regarding the quality of study programs in institutions of higher education throughout Israel, and to ensure the continued integration of the Israeli system of higher education in the international academic arena.

As part of this important endeavor we reach out to world renowned academicians to help us meet the challenges that confront the Israeli higher education by accepting our invitation to participate in our international evaluation committees. This process establishes a structure for an ongoing consultative process around the globe on common academic dilemmas and prospects.

I therefore deeply appreciate your willingness to join us in this crucial enterprise.

It is with great pleasure that I hereby appoint you to serve as chair of the Council for Higher Education's Committee for the Evaluation of **Physics** departments. In addition to yourself, the composition of the Committee will be as follows: Prof. Laura Greene, prof. Herbert Levine, prof. Michal Lipsan and prof. Yael Shadmi.

Ms. Maria Levinson-Or will be the coordinator of the Committee.

Details regarding the operation of the committee and its mandate are provided in the enclosed appendix.

I wish you much success in your role as a member of this most important committee.

Sincerely,

Prof. Ido Perlman
Vice Chair,
The Council for Higher Education (CHE)

Enclosures: Appendix to the Appointment Letter of Evaluation Committees

cc: Dr. Varda Ben-Shaul, Deputy Director-General for QA, CHE
Ms. Maria Levinson-Or, Committee Coordinator

Appendix 2: Visit Schedule

<u>Physics - Schedule of site visit</u> <u>Bar-Ilan University</u> <u>Wednesday, June 12 ,2019</u>		
09:00-09:30	Opening session with the head of the institution	Prof. Miriam Faust, Rector Prof. Amnon Albeck, Vice-Rector
09:30-10:00	Meeting with the Dean of the Faculty of Exact Sciences	Prof. Richard Berkovits, Dean, Faculty of Exact Sciences
10:00-11:00	Meeting with the Head of the Physics Department	Prof. Lior Klein, Head of the Physics Department
11:00-11:15	Break	Closed-door meeting of the committee
11:15-13:00	Presentations – experimental research groups (including research lab visits)*	Prof. Avi Peer Prof. Beena Kalisky Prof. Yuval Garini presentations – research groups
13:00-13:45	Lunch (in the same room)	Closed-door meeting of the committee
13:45-15:00	Presentations – theoretical research groups	Prof. Eli Barkai Prof. Richard Berkovits Prof. Shlomo Havlin Prof. Asaf Peer presentations – research groups
15:00-15:30	Tour of teaching labs	
15:30-16:15	Meeting with BSc students	
16:15-17:00	Meeting with research students - MSc and PhD	
17:00-17:45	Meeting with Alumni	
17:45-18:00	Break	Closed-door meeting of the committee
18:00-18:30	Closing meeting with heads of institution, Dean of the Faculty and the Head of the Physics Department	Prof. Miriam Faust, Rector Prof. Amnon Albeck, Vice-Rector Prof. Richard Berkovits, Dean, Faculty of Exact Sciences Prof. Lior Klein, Head of the Physics Department