



# EVALUATION OF PHYSICS AT BEN-GURION 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 of<sup>1</sup>:

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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

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<sup>1</sup> 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.<sup>2</sup>
- 1.6 This report deals with the Department of Physics at **Ben-Gurion University**. The Committee's visit to Ben-Gurion University took place on June 18<sup>th</sup> 2019. The schedule of the visit is attached as **Appendix 2**.
- 1.7 The Committee would like to thank the management of Ben-Gurion 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

The Ben-Gurion University of the Negev (BGU) has a prominent physics department with a record of accomplishment in a variety of fields. Popular with students, the department has a broad admission policy, but maintains high standards for its physics programs, leading to a larger than average dropout rate. The graduate program draws heavily from its undergraduate population. Students are generally happy with their experiences at BGU, and many have gone on to successful careers both in industry and in academia.

In comparison to the other major Israeli universities, the faculty in physics at BGU is rather small, making it difficult to achieve critical mass in a wide range of disciplines. Nevertheless, the department has chosen to hire faculty covering all of the major subdisciplines of physics: condensed matter, astrophysics, particle physics, nonlinear dynamics, and atomic and molecular physics, and it has established **distinguished efforts in most areas**. The department also has connections to the Blaustein Institutes for Desert Research, although these could be further strengthened, particularly in the areas of biophysics and statistical physics.

In general, our committee has an overall positive view of the physics programs at BGU. We recommend that the department undertake a significant renovation of its first-year teaching labs, a project which, we understand, is already underway. In addition, we believe that the department can take a more proactive approach toward improving the diversity of its faculty, and we suggest

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<sup>2</sup> 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.

that increased attention should be given to monitoring the progress of its MSc students.

## Section 3: Observations

### 3.1 Introduction

The Ben-Gurion University of the Negev is one of Israel's youngest and most vibrant universities. Since its founding in the late 1960's, BGU has developed into a first-class research institution, with major programs in the sciences and the humanities. Physics is one of its more distinguished academic departments, with significant research efforts in most of the major subdisciplines in the field. BGU remains popular with students due to its affordable location and welcoming environment.

### 3.2 Organizational Structure

Physics at Ben-Gurion University (BGU) is located within the Natural Sciences Faculty. It is a relatively small department, with 21 regular positions, with a significant number of adjuncts and with a few special KAMEA positions that will soon disappear due to retirement. The department seems to be highly regarded, by the current university administration. The faculty is structured into a set of different theory groups working on related topics, with at least four members each, complemented by a set of experimental laboratory-based groups. The groupings do not appear to have any administrative functions per se, as decisions are made at the department and natural science faculty levels.

One complicating aspect for BGU physics is the presence of a significant number of physicists at the Jacob Blaustein Institutes for Desert Research (BIDR) in Sde Boker. While these individuals are listed as adjunct faculty and do take part in some teaching activities, the overall coupling between them and the department proper is not strong. We were not actually scheduled to meet with any individuals from BIDR, which may perhaps confirm the relatively weak connection to the department. Finding ways to increase cooperation with BIDR would definitely be of benefit for some department research efforts that are otherwise below critical mass.

### 3.3 Self-Evaluation and QA

The Rector's Office at BGU is in charge of Quality Assurance (QA) and was responsible for the implementation of the self-assessment. The Vice Rector, Prof. DeBotton, primarily supervised the process, with the support of the QA coordinator. They worked closely with the department, which was responsible for the content.

The department took the self-evaluation process seriously and involved different stakeholders among its faculty and staff, and across the university. The report identifies several strengths and weaknesses, and it seems that the department is working to address and amend the weaknesses detected.

While this was a useful exercise, the report states that the department conducts continuous quality assurance processes, independent of external reviews. This is done via various departmental committees (Hiring and Promotion, Teaching, Infrastructure, etc.), as well as by receiving feedback and critical assessments from other units and stakeholders in the university.

### 3.4 Undergraduate Education

The department offers a single-track physics program as well as several joint programs, mostly with engineering, as well as a program in brain sciences. The university would like to promote interdisciplinary programs, but the physics department has been cautious about this. The joint programs have countered the drain of incoming students towards colleges, so that overall the number of students has remained stable in recent years. Each of the joint programs has a designated coordinator in the physics department.

The department has a broad admission policy, but maintains high standards once students are enrolled, so the dropout rate after the first year is high, around 50%.

There is on-going discussion of, and experimentation with, non-traditional teaching methods. Some lectures are recorded, and some lecture notes are posted online. There is a university-wide initiative to promote the use of tablets plus audio recording for lectures, which has been adopted in the physics department as well. Students may benefit from having both the written notes and recordings available, although they consider video recordings of lectures to be far more effective, and these are mostly lacking for physics at BGU. There has been some experimentation with active tutorials, with students solving problems on their own, and then presenting their solutions on the board.

Two university-wide programs exist for excellent students: Ashalim and Dkalim, in which students are assigned an advisor, do rotations with different research groups, and receive some financial support.

The lab program is undergoing major revisions, with physics faculty taking over and devoting much effort to the process. So far, this process was completed only for the 3rd year lab, and it is now very high quality, with students performing independent long-term projects. There is an oral exam for each of these projects. Much work needs to be done on the 1st and 2nd year labs, but the department is well aware of this, and is working on it.

The department tries to monitor the progress of their top students, and it encourages students to engage in research projects. Students take a research course, in which faculty give research presentations, and this has been an effective means of engagement. There have also been retreats on the Sde Boker campus.

### 3.5 Graduate Education

The masters and PhD programs in physics at BGU are similar in structure and content to those offered at other Israeli universities. The MSc is a two-year program, where students do coursework primarily in their first year, and a master's thesis project in their second. The coursework requirements include QM 3 and Stat Mech for everyone, and then a series of specialized courses depending on their research fields. The PhD is a four-year program involving original research leading to a thesis. There is also a direct PhD track, which can lead to a faster time to PhD for exceptional students.

In contrast to some of the other universities, the graduate program in physics at BGU is smaller in size, and so is the faculty. As a consequence, not all advanced courses can be taught with regularity, and students are occasionally unable to fulfill their course credit requirements with the course offerings on campus. In these situations, they have fended for themselves, and found relevant courses to enroll in at the other universities. A further problem is that due to low enrollments, advanced courses typically only have one or two students, and they are converted to reading courses. This works fine, except that the university assigns less credit to reading courses, a policy that does not make sense and should be amended.

In the PhD program, the student is assigned a committee of faculty, including his or her advisor, who meet with him/her once per year to assess progress. Students felt that this was working well, and that they were getting the mentoring they needed to be successful. At the master's level, on the other hand, there appears to be less attention to the students. We heard of a case in which an advisor went on sabbatical, leaving students stranded to complete their research projects on their own.

### 3.6 Faculty and Human Resources

New appointments are officially made at the Dean's level after possible candidates are identified, initially in the research groups and eventually by the appointments committee in the department. Control of new slots seem to rest primarily with upper management, and this has been a source of friction in the past, which may perhaps be alleviated with the arrival of both a new president and a new rector. Expansion of the department is an important issue, as BGU physics has opted for breath of physics coverage as opposed to concentrated efforts in a few areas. As mentioned earlier, this has left some research groups

at clearly subcritical levels. The lack of concentration also makes it harder to compete with the larger and more established departments in other Israeli institutions. Nonetheless Ben-Gurion does manage to attract high-quality young faculty, partially due to the benefits of living away from the highly congested and expensive Tel Aviv region.

As for the other Israeli universities, the experimental groups are supported by technicians, with 50% of the salary covered by the university. While this system has created problems elsewhere, it does seem to work at BGU. Apparently, a popular strategy is for two labs to combine their 50% technical support each to fund a 100% University-funded individual. Since the labs are somewhat small on average, this procedure appears to ensure sufficient support and creates a relatively attractive position that is less subject to fluctuations in grant support than is the case at other locations. This may become a more serious issue if the department gets a chance to expand and hire more experimentalists.

### 3.7 Research

#### **High Energy**

The BGU HEP group has four theory PIs, working in four distinct areas: the interface of early universe cosmology and string/field theory (Brustein), modified gravity (Guendelman), collective phenomena and hydrodynamics in quark gluon plasma (Lublinsky), and LHC physics (Kats). The latter is a new effort, started with the hiring of Kats last year, with a focus on searches for beyond the standard model, such as multiple resonances.

Another recent hire is Citron, an ATLAS experimentalist working on heavy ion collisions, and quark gluon plasma, as well as on R&D for a new calorimeter. This was an excellent move, complementing Lublinsky's theoretical research. It seems that much could be gained by further consolidating the group's activity, through the hiring of an ATLAS experimentalist working on BSM searches, and another theorist in this area. This would allow Kats to maintain his high-profile activity and tie in with the heavy ion group.

#### **Biophysics**

On its Beer Sheva campus, the BGU Physics department has a small effort in experimental biophysics. The Feingold lab works on the contractile ring involved in bacterial cell division whereas the Krichevsky group studies two systems, chemical communication between immune cells and the spatial packing of DNA inside the cell nucleus. These efforts rely on fairly standard microscopy methods available in the biophysical community. There is also some connection to the physics of neural systems, but that program is led by adjunct (as opposed to regular) physics faculty members.

The committee had the feeling that this field is subcritical. For example, there is no regular seminar in biophysics, and there are only a limited number of questions and methodologies being addressed by these two groups. One obvious approach to alleviating this problem would be to create stronger ties with BIDR, where there are several faculty members (with adjunct positions in the Physics Department), who work on biological systems and related nonlinear processes. The apparent lack of any ongoing active connection to those groups seems to be a lost opportunity.

### **Condensed Matter**

The experimental condensed matter physics group members (Manassen, Rich, and Muntaser) have developed techniques that include: a) combined scanning tunneling microscopy and magnetic resonance techniques to detect single spins and hyperfine splitting in nuclei; and b) spatially, spectrally, and temporally resolved electron beam probes to study optical properties of semiconductor quantum heterostructures and nanostructures. Muntaser is a new hire who will focus on imaging and manipulating the electronic structure of quantum materials, including high-temperature superconductors, topological insulator thin films, and heterostructures, and measuring their electronic structure with angle-resolved photoemission spectroscopy (ARPES). The two existing labs are well-equipped and the third is promising.

The condensed matter theory group (Bar Lev, Cohen, Grosfeld, Meidan, Meir, Schechter) is strong and cohesive. Bar Lev just arrived this year and is making use of a large cluster for computation that has also just arrived. Topics of research include topological order in novel materials including Majorana fermions, statistical mechanics of disordered materials, and superconducting qubits for quantum information. There is a great deal of collaboration among the group members since there is significant overlap in their interests. The newer theorists are quite talented and dynamic, and this group promises to gather increased recognition at the international level.

### **Astrophysics**

The astrophysics group at BGU has a distinguished record of contributions, primarily in theoretical high energy astrophysics, with an emphasis on plasma astrophysics and collisionless shocks. Eichler and Lyubarsky, both of whom are nearing retirement, have made major contributions to these fields. They are complemented by Gedalin, who has focused on space physics and space weather. The more recent appointments, Keshet, Kovetz, and Zitrin, have brought a new interest in cosmology through analytic and numerical modelling of clusters of galaxies and black hole environments, gravitational lensing, line-intensity mapping, and using transient sources to provide constraints on dark matter.

This group is quite active and is reasonably well-known internationally. They have procured a cluster with 2000 cores to support their computational work, and they have acquired time on the Gemini Observatory for observations. There are collaborations with other astrophysics groups in Israel, but this is not the standard practice.

### AMO

The AMO group at BGU has three faculty members that are active in research (Folman, Bar, and Frumker). They cover a very wide range of research topics including nitrogen-vacancy centers in diamond, atomic vapor at room temperature, cold atoms, and fundamental and applied quantum technology research in areas such as atomic clocks and magnetic sensors. They have the only atom chip laboratory in Israel. There are also studies of biological molecules, and chemical bonds through light interactions with matter, and experimental and theoretical studies at the interface of ultrafast nonlinear optics, attosecond science, and nanoscience. The cold atom lab is extremely large and has a wide international footprint. The attosecond laboratory of Frumker, still under construction, looks very promising.

### 3.8 Students

Many students come to BGU because of the attraction of student life and affordable living in the area. They find the physics program to be very demanding, but have appreciated the attitude among the physics faculty, who have been helpful and supportive.

The department recently started offering a 2-week preparatory ("Hatchala") program in the beginning of the 1st year, which has been quite useful. Some students had trouble with the "filtering" atmosphere, while others merely think that physics is demanding, and professors have high expectations. There is not much formal support for struggling students. The Student Dean offers a tutoring program, but there are no tutors who can help with physics courses.

The quality of instruction varies, and the students are not sure whether their teaching evaluations make any difference. They were very critical of the 1st year lab, which is low-level, has old equipment, and is very crowded, but they appreciated the 3<sup>rd</sup> year lab, which is good and has interesting experiments (Doppler shift, superconductivity, Mossbauer). They feel that more theory background is needed, and that the labs should be better coordinated with their lecture courses.

In terms of on-going mentoring, the Student Dean runs a program where a 2nd or 3rd year student advises a group of 5 incoming students. However, this has mostly been helpful for non-academic issues.

There is no mentoring regarding job options outside academia, nor networking with alumni. The students believe that it is easy to find a job once you have a graduate degree, but very hard if you only hold a BSc in physics.

### 3.9 Infrastructure

Both the research laboratories and the teaching laboratories for physics at BGU are in reasonably good condition. Although, provision of the needed laboratory revisions and equipment purchases for new experimental hires is very expensive, the university has come through in most cases and provided the necessary resources. An exception occurred with the attosecond laboratory renovation, which had special requirements, and took much longer than expected. Fortunately, we learned that this project is finally nearing completion to the satisfaction of the affected faculty member.

In terms of future space needs, the current building is near saturation. However, there is the possibility for expansion of laboratory space, in the north campus area, where there is still bare land available, suitable for new construction. The university is considering allocating space in one of the planned new buildings for quantum labs, which are specialized and expensive. We also learned that Chemistry will be moving into a new building under construction. They will release some space, which could possibly go to physics.

In terms of the teaching labs, there has been substantial renovation of the 3<sup>rd</sup> year labs, and these are now in very good shape. The 1<sup>st</sup> and 2<sup>nd</sup> year labs are adequately equipped, but these also need serious renovation, and that is being addressed now.

### 3.10 Diversity

Across the entire campus, about 50% of the student population at BGU is female. The Bedouin population, mostly women, make up 9.9% of the undergraduate population, which is well below the demographics of the area. The fraction of Ultra-Orthodox is well below that of the Bedouin, but the precise number is not known.

In physics, there are 21 faculty members, of which one is Arab and two are female. Of the 65 physics graduate students, 1 or 2 are women and it was thought that 2 are Bedouin. There is a total of 170 undergraduate physics majors, and in each year there are 4 or 5 women, with an occasional Bedouin woman, and very rarely a Bedouin man. The dropout rate between the first and second year is about 50%, but that rate is lower for the women and the underrepresented minorities. Nothing proactive is done at the department level to recruit women or underrepresented minorities.

## Section 4: Recommendations

### Essential:

- **Complete the renovation of the first-year student labs.** The material and equipment in the first-year lab is dated, and the students feel unchallenged in this course. Since this is a key component of the first-year experience, and the dropout rate is high, it is important for the department to correct this as soon as possible.

### Important:

- **Take concrete steps to improve the gender and minority representation among the faculty.** The department has not taken a proactive approach to improving diversity. They must ensure that every effort is made to identify and recruit outstanding women and minority candidates.
- **Improve the mentoring of students in the MSc program.** While the department does a good job at monitoring the progress of their PhD students, the same is not true for students enrolled in the MSc program. They should ensure that these students receive the guidance they need to successfully obtain their degrees.
- **Develop tighter and more meaningful connections to relevant BIDR faculty.** In the areas of biophysics and statistical physics, the research programs on the Beer Sheva campus are subcritical. Tighter connection to physicists in these fields located at Sde Boker can improve the balance, and result in a significantly stronger program at BGU overall.

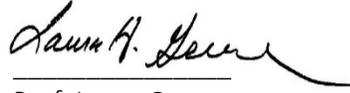
### Advisable:

- **Provide resources for grad students to attend conferences and summer schools outside Israel.** Grad students are under the impression that there is no funding available for them to attend such professional meetings, particularly the summer schools. This situation should be addressed, as this should be a valuable component of their graduate experience.

Signed by:



Prof. Steven Kahn  
Committee Chair



Prof. Laura Greene



Prof. Herbert Levine



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 Lipson 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

<p style="text-align: center;"><u>Physics - Schedule of site visit</u>  <u>Ben-Gurion University</u>  <u>Seminar Room 2<sup>nd</sup> floor Sacta-Rashi Physics Building</u>  <u>Tuesday, June 18 ,2019</u></p>		
09:00-09:30	Opening session with the Academic Leadership of Ben-Gurion University of the Negev	Rector of BGU Prof. Chaim Hames Prof. Gal deBotton, Vice Rector
09:30-09:50	Meeting with the Head of the Parent Unit	Prof. Michal Shapira. Dean of the Faculty of Natural Sciences
10:00-11:00	Meeting with the leadership of the Physics Department	Prof. Doron Cohen, Head of the Department Prof. Eytan Grosfeld, Deputy Head of the Department Prof. Michael Gedalin (standing in for Chairman of the Teaching Committee)
<b>11:00-11:15</b>	<b>Break</b>	<b>Closed-door meeting of the committee</b>
11:15-12:30	Presentations – research groups (including research lab visits)*	Dr. Evgeni Katz - HEP Dr. Uri Keshet - AST Prof. Eytan Grosfeld - CMT Prof. Ron Folman – Cold Atoms (presentation, not lab visit)
<b>12:30-13:15</b>	<b>Lunch (in the same room)</b>	<b>Closed-door meeting of the committee</b>
13:15-14:30	Meeting with research students	
14:30-15:15	Presentations – research groups (including research lab visits)	Introductions by Dr. Evgeny Frumker (Attosecond Science) and Prof. Mario Feingold (Biophysics) followed by visits to research labs I
15:15-15:45	Meeting with BSc students	
15:45-16:30	Tour of teaching labs	Accompanied by Yaakov Biton, the Labs Manager, and Prof. Frumker, academic responsibility
16:30-17:15	Meeting with Alumni	
<b>17:15-17:35</b>	<b>Break</b>	<b>Closed-door meeting of the committee</b>
17:35-18:00	Closing meeting with academic leadership, Dean of the Faculty of Natural Sciences and the Head of the Physics Department	Prof. Chaim Hames, Rector Prof. Gal deBotton, Vice Rector Prof. Michal Shapira. Dean of the Faculty of Natural Sciences Prof. Doron Cohen, Head of the Physics Department