



# EVALUATION OF PHYSICS AT ARIEL 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 **Ariel University**. The Committee's visit to Ariel University took place on June 17<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 Ariel 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

- 2.1 Ariel University (AU) has a Physics Department in its Faculty of Natural Sciences that is accredited to award the BSc degree in physics, as well as joint degrees with other disciplines. The university is in the process of proposing the establishment of an MSc program in physics as well. At present, there are graduate students at AU pursuing PhD's under the supervision of physics faculty, but these have no formal affiliation with the department.

The faculty of the Physics Department are engaged in a diverse program of research covering various aspects of condensed matter physics, theoretical high energy physics, astrophysics, accelerator physics, biophysics, and geophysics. The logic behind this particular collection of activities is not entirely clear, but many of the faculty are research-productive, and they have provided interesting avenues for student research engagement, both at the undergraduate and graduate levels.

Student satisfaction is generally high, as gauged from interviews with both existing students and recent alumni. While we have some concerns about the rigor of the undergraduate physics curriculum, the alumni who have gone on to both academic and industry careers feel that they have been well-prepared.

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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.

In our view, we do not find the case for the establishment of an MSc program to be compelling at this time. The department is advised to better articulate the case for such a program, given that the MSc programs at other Israeli universities are not presently over-subscribed. We also recommend that the department engage in a reevaluation of the rigor of its undergraduate physics courses, and that they take some proactive steps to improve the diversity of its faculty.

## Section 3: Observations

### 3.1 Introduction

In 2012, Ariel University was fully accredited as an independent university in Israel. AU now has active degree programs in a wide range of fields in the natural sciences, social sciences, humanities, and professional disciplines. The Physics Department was first established in 2004, and its BSc programs in physics were accredited in 2008. Since that time, AU has educated a number of students who have gone on to graduate programs at other universities and to careers in industry. The department has a reputation for providing a welcoming and supportive environment for students who are eager to study physics.

### 3.2 Organizational Structure

At Ariel University, the Physics Department sits within the Natural Sciences Faculty, and new hires have to be authorized and approved by the Dean. There is the necessity that a teaching slot be available before this can happen; we were not told exactly how the number of teaching slots is determined. Physics is led by a Department Head, and there is no finer decision-making structure within the department.

### 3.3 Self-Evaluation and QA

The Head of the Physics Department coordinated the self-evaluation process and held regular meetings with faculty to explain and facilitate the process. All faculty members were involved in preparing the self-evaluation report, either by drafting specific sections or by collecting required data.

The Head of the Academic Assessment and Development unit, Prof. Davidovich, accompanied the department in the process, and provided guidance and advice, as well as topical workshops (writing syllabi, teaching methods, etc.), as the

institutional coordinator for QA. Meetings were also held with the senior administration of the university as part of the process.

The department took the process seriously and used it to identify strengths and weaknesses relating to students, the study program, and infrastructure. The report states that the majority of the weaknesses identified were or are being addressed by the department, including revising the study programs, revising admission criteria, recruiting new faculty members, advertising for open faculty positions, and revising departmental policies. The department also used its meeting to discuss and revise its strategic plan.

### 3.4 Undergraduate Education

The Physics Faculty at AU offers a BSc degree in physics, as well as several variations of combined degrees, such as “Physics in computing specialization”, and a dual degree with mechanical engineering. The physics curricula for these programs are similar to those offered at other universities, although our cursory examination of some of the course materials suggested that the level of rigor is appreciably lower than would be found elsewhere. AU is clearly admitting students with weaker ability and/or preparation, and they are committed to helping these students succeed. The philosophy is markedly different than that found at the other universities, where high standards are maintained, and it is expected that significant fractions of students may drop out after the first year. At AU, the standards are more relaxed, but interestingly, the dropout rates are not much better. ~ 50% of the physics students leave after one semester.

### 3.5 Graduate Education

AU is not currently authorized to award MSc degrees in physics, although they are in the process of preparing a proposal to CHE to achieve that status. They do, however, have graduate students associated with the Physics Department. These are PhD students, who work with individual advisors. Our understanding is that certain individual faculty members are approved to act as PhD advisors at the university, irrespective of their connection to particular departments. There are also PhD students from other universities, who are receiving their primary supervision by AU faculty. There are 11 PhD students who are registered at AU, and 3 additional ones from other universities, who are working with AU Physics faculty.

Since there is no master’s program, the PhD students enter this status, having taken the relevant coursework and been awarded master’s degrees elsewhere.

Our discussions with current students enrolled in the program, verified that this was the case, although not all of the students had done their bachelor's degree and master's degree in physics. So, these should not be considered PhDs in physics in the usual sense.

The current system, with a PhD program but no feeder master's program, does not make sense to us in its current form. The university wants to normalize the situation by moving towards a fully functional advanced degree program. The question then becomes, is the AU Physics Department ready to move definitively toward that goal. The department appears to have sufficient faculty numbers and sufficient research breadth in at least a few fields, to meet the needs of the relatively small number of MSc students that would be initially enrolled. In addition, the needed student support should add only a small financial burden to the department. They have shown that they can successfully produce BSc students who are competitive for both industry positions and advanced degrees in academia.

However, the current faculty is weak in several key areas of research that usually anchor graduate physics programs at universities. This is especially true in condensed matter, but also applies to atomic, molecular, and optical physics, high energy physics, and other fields. Furthermore, it is not clear to us that adding another full university-based graduate physics program in Israel is necessary at this time, given the anticipated student population.

Based on the arguments above, we are not prepared to make an explicit recommendation on this issue. CHE will have to decide what the minimum requirements for the program are, and what are the overall benefits to Israeli physics to establish the MSc at AU at this time.

### **3.6 Faculty and Human Resources**

Once a possibility for a new faculty member is identified, the department searches for candidates both directly via advertising and through indirect channels utilizing contacts of the current faculty. Appointments are considered by dedicated committees, both at the department and at the Natural Sciences levels. The goal is to bring in people with credible research portfolios who can establish effective efforts at AU. We discuss the existing research program in more detail below, but our overall opinion is that this system has yielded mixed results.

In general, there seems to be very little in the way of strategic planning leading to a balanced research-active department. When asked about new directions, the department leadership only expressed a general desire to move into quantum information research, a field which is being developed extensively elsewhere in Israel. While such a move may not be unreasonable, in and of itself, it does not constitute an actual strategic plan. If it is serious about developing a full graduate program, the department must make critical decisions regarding how, and in which physics subfields, they can become competitive for available young Israeli talent. Right now, the department is still in transition from its college days, when many hires were made without much attention to the issue of research or graduate education. In order to move into “the big leagues”, a more competitive strategy will be required.

### 3.7 Research

#### **Biological/medical physics**

This is clearly an area that needs major improvement. We were told that there is an emphasis on physics that might be connected to the proposed Ariel medical school, and also that one possibility for the MSc program would be a track involving medical physics. However, these statements are not consistent with the current makeup, and especially with the current research output, of the physics faculty. If there is to be a serious effort in this area, several new young hires will need to be made.

#### **CMP and Laser Research**

Theoretical Condensed matter physics (Lewkowicz and Zubkov) at Ariel covers two general areas. The first is focused on understanding the electronic transport properties of graphene and Weyl semimetals, combining topology with correlated electron physics. The second is more concerned with formalism and applies methods of quantum field theory to condensed matter physics and methods of condensed matter physics to high-energy physics theory. The members of this group do collaborate with one another, and they also collaborate internationally, mostly in the formalism research.

The experimental condensed matter physics program (Farber, Musin, Pogreb, Whyman, and Cheskis) predominantly involves engineering research, focusing on thin film growth for applications for solar cells, photovoltaics, spintronics, and magnonics. The low temperature physics group, which is more fundamental,

uses electronic transport and THz spectroscopy to study superconductivity and strongly correlated electron systems.

In experimental laser physics (Ishai, Gaft, and Nagli) a variety of techniques are employed including, dielectric and THz spectroscopies, laser induced time resolved luminescence, laser induced breakdown spectroscopy (LIBS), and CW and gated Raman spectroscopies. There is good deal of work on minerals, and the role of water in crystal minerals and biological systems.

The experimental condensed matter and laser physics areas suffer from extremely low funding: Startup packages are about one tenth those of other Israeli universities (~\$100,000). However, given the applied and engineering nature of much of the research, they have had success in obtaining financial and equipment support from industry. In addition, the limitations they have faced in obtaining intramural funding have generated a certain amount of ingenuity and creativity among the faculty to get experiments done with the resources they have been able to muster.

### **Astrophysics, Atmospheric Science, and Accelerator Science**

There are two astrophysicists on the Physics Faculty, both theorists, but who work at opposite ends of the field. Kashi works on problems in stellar structure and evolution, while Ben-Dayon is an early universe cosmologist. Both remain active. The department is also in the process of hiring another astrophysicist, Lev Tal-Or, who is currently a postdoc at Tel Aviv University, and who works on the detection of extrasolar planets.

Weinstein is a mathematical relativist, who works on topics in differential geometry and partial differential equations. He has a joint appointment with the Mathematics Faculty.

The Reuveni group is involved in remote sensing investigations using a variety of both space- and ground-based sensors and technologies. They are studying a wide range of topics, ranging from variations in the Earth's gravity and rotation, to remote sensing of different atmospheric layers, and space weather.

Nause leads a large program designed to construct a compact, table top, 6 MeV electron linear accelerator, using an S-band klystron donated by SLAC National Accelerator Laboratory. The primary goal is to produce intense short pulses of THz radiation by passing the beam through a super-radiant undulator. This is a novel program in Israel, and, when completed, could produce a versatile THz facility, suitable for a range of applications.

## Particle Physics

There are three faculty members trained in particle physics, all of whom are theorists. Prygarin and Bondarenko have worked on topics involving the construction of effective field theories at high energy and low- $X$  QCD. Zubkov, as mentioned above, is interested in applying field theoretic techniques developed for particle physics to problems in condensed matter physics, and vice versa.

### 3.8 Students and Alumni

#### Students

The undergraduate students we interviewed were very happy with the program. They found the faculty to be uniformly friendly and welcoming. The lectures are generally good, and the classes are small and interactive, a reflection of the fact that the physics enrollment is much less than at other universities. They also praised the student lab courses, which they felt gave good practical exposure.

The existing graduate students we interviewed, are a “mixed bag”, reflective of the fact that since there is not a formal master’s program, they are engaged in PhD research with individual advisors, with only loose connections to the actual physics department. Not all of them can even be considered physics students in the usual sense. They have all pursued some prior graduate level research at other universities, and their reasons for moving to AU are varied. While all expressed satisfaction with their current PhD research plans, they did not convey any general impressions about the AU physics program as a whole.

#### Alumni

Our discussions with AU alumni were generally very positive. All expressed satisfaction with the undergraduate education that they received at AU, and they indicated that they felt that they had been well prepared for their future endeavors. Several had gone on to pursue graduate studies, either in physics at other universities, or in other fields at AU. The alumni praised the welcoming attitude of the faculty in the physics department, and they said that they had benefitted from the relatively small number of physics students in the program, compared to other universities. The student culture in physics at AU was collaborative and self-supporting.

### 3.9 Infrastructure

Research labs at AU are generally in good shape, however the funding available for equipment in startup packages is very limited. The accelerator physics lab is a glaring exception, where significant resources have been spent to outfit that facility. It was unclear to us how such priority decisions are made at AU.

The teaching labs are well-equipped and are appreciated by the students.

### 3.10 Diversity

The diversity in this department is particularly low. There is a single woman faculty member out of a total of 23. There are 11 PhD students, and one is a woman. Out of the approximately 20 undergraduate physics majors per year, typically 3 or 4 are women. There are Arab students on campus, but we were not given a number of how many were enrolled in physics. Similarly, we did not get a number for the Haredi. They stated that they would like to have a more diverse population, but they do not get many applicants. They have no proactive efforts to increase their diversity.

## Section 4: Recommendations

### Essential:

- **Reconsider plans to establish an MSc program in physics at this time.** Given the somewhat spotty nature of the existing research programs in the key sub disciplines of physics at AU, we do not see a compelling argument to proceed quickly with the establishment of a new MSc program. The department needs to engage in a higher level of strategic planning, which might lead to a better articulation of the case for such a program. From a national perspective, we do not see a need for this new program in light of the fact that the MSc programs in this field at the other, more established, Israeli universities are still mostly undersubscribed.
- **Reexamine the rigor and standards applied to the undergraduate physics program.** AU has done a good job at attracting and nurturing students who would otherwise not pursue physics as a discipline at the university level. However, it is unclear to us that the appropriate standards have been maintained, even in the face of a rather high dropout rate.

**Important:**

- **Improve the situation for the provision of startup funding for new experimental hires.** AU cannot compete for top experimentalists, given the startup resources they have available. Significant funding has been provided in some cases (e.g. in accelerator physics), but the prioritization process behind such decisions was not made apparent to us. Other experimentalists have had significant difficulty in finding the resources necessary to establish viable research programs.
- **Take more proactive steps to improve the diversity of the faculty.** The gender and minority representation of the faculty is especially low at AU and can be improved. Every effort should be made to identify and recruit outstanding women and minority candidates.

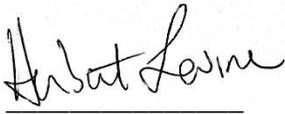
Signed by:

Handwritten signature of Steven Kahn in black ink, written over a horizontal line.

Prof. Steven Kahn  
Committee Chair

Handwritten signature of Laura Greene in black ink, written over a horizontal line.

Prof. Laura Greene

Handwritten signature of Herbert Levine in black ink, written over a horizontal line.

Prof. Herbert Levine

## 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

<b>Physics - Schedule of site visit</b> <b>Ariel University</b> <b>Monday, June 17 ,2019</b>		
09:00-09:30	Opening session with the head of the institution	Prof. Yehuda Danon, President, prof. Michael Zinigrad, Prof. Mally Shechory-Bitton, Vice-Rector. Prof. Nitza Davidovitch, Head of quality assessment and academic instruction
09:30-10:00	Meeting with the Dean of the Faculty of Natural Sciences	Prof. Gary Gellerman
10:00-11:00	Meeting with the Head of the Physics Department	Prof. Raichlin Yosef and Prof. Meir Lewkowicz
<b>11:00-11:15</b>	<b>Break</b>	<b>Closed-door meeting of the committee</b>
11:15-13:00	Presentations – research groups (including research lab visits)*	Prof. Zubkov M Prof. Levitan J Prof. Farber E Prof. Gaft M Prof. Pogreb R Dr. Kashi A Dr. Ben Dayan I Dr. Bondarenko S Dr. Schiffer M Dr. Weinstein G Dr. Ben Ishai P Dr. Musin A
<b>13:00-13:45</b>	<b>Lunch (in the same room)</b>	<b>Closed-door meeting of the committee</b>
13:45-14:30	Presentations – research groups (including research lab visits) *	Dr. Naus Ariel Dr. Or Gilad
14:30-15:00	Tour of teaching labs	Dr. Cheskis Dima Dr. Reuveni Yuval
15:00-15:45	Meeting with BSc students	
15:45-16:15	Meeting with PhD students	
16:15-17:00	Meeting with Alumni	Lior Lifshiz, Klen Avi, Horowits Oded, Luz Eitam, Balal Yael
<b>17:00-17:15</b>	<b>Break</b>	<b>Closed-door meeting of the committee</b>
17:15-17:45	Closing meeting with heads of institution, Dean of the Faculty and the Head of the Physics Department	Prof. Yehuda Danon, prof. Michael Zinigrad, Prof. Mally Shechory-Bitton, Prof. Gary Gellerman, Prof. Raichlin Yosef, Prof. Nitza Davidovitch