

# The academic career in physics as a “deal”: Choosing physics within a gendered power structure

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This research focuses on the absence of women among academic staff in physics ~~is in the focus of our research~~. To explore the causes of this gender imbalance, we focused on the decision-making junction between obtaining a Ph.D. diploma and choosing a postdoctoral appointment. We used the mixed-methods paradigm, combining a nationwide representative survey among of Ph.D. students in Israel ( ~~$n = 267404$~~  $n = 267$  respondents out of 404 questioned) and interviews with Ph.D. students and postdoctoral fellows ( $n = 38$ ). The theoretical novelty that we ~~suggest~~propose is to viewing such career decision-making as a “deal”; ~~which that~~ involves contextual, organizational, and individual variables and their intersection. Young women are examining the components of this deal: what it offers them and what prices they will have to pay, but their decision is made within a gendered power structure. Studying both context factors and agency, we reveal the multiple hidden ways in which gender operates as a power structure, putting up barriers to women’s academic careers. This latent power structure influences women’s decision-making and experiences in several ways. In the academic field, it produces unequal competition in a male-dominated playground. In the social sphere, choosing a demanding academic career is seen as disrupting gender order. Within the family, women carry a greater burden of family work and give precedence to their husband’s career and preferences. Within this social structure, women who decide to follow an academic career feel that they must excel, and this demand for “excellence” acts as a hidden mechanism within the gender ed power structure that may prevent talented women from pursuing an academic career in physics.

## I. INTRODUCTION

The small proportion of women among university students and academic staff in math-intensive disciplines is an issue of much significant concern. In the last two decades, much research has ~~been carried out in this regard~~focused on this subject, and much effort has been invested in trying to improve the situation. Of particular interest is the field of physics, where the gender imbalance in the academy is particularly severe, and where women/female participation has shown no significant increase ~~in despite of~~ dedicated efforts in the USA [1], in Europe [2], and globally [3].

~~Our~~The present study focusses on gender imbalance in the field of physics in the Israeli academia. The percentages of women among physics Israeli physics students and academic staff are even poorer/worse than in the USA and ~~w~~Western Europe: 16% among graduate students and 6% among faculty members [4]. These small/low rates are even more striking when compared to with other fields in the Israeli academy, such as medicine, where women constitute 69% among of graduate students and 35% among of faculty members, or biology, where the proportion is 58% and 30%, respectively.

Looking at the data, we asked ourselves why so few women pursue an academic career in physics. As a first step on the way to toward answering this question, we investigate the decision-making of Israeli students, both

male and female, when considering an academic career trajectory. Therefore, we pose the following three research questions: How do Ph.D. students perceive the academic career path? What are the considerations of female student ~~considerations in going~~ for choosing a postdoctoral training/appointment abroad? In what ways How are women’s considerations for and against pursuing an academic career shaped (constructed) by gender? To answer these questions, we use a mixed-methods research methodology, that combinges a representative quantitative survey of all physics Ph.D. students in Israel, with qualitative tools and conduct interviews with female Ph.D. students and postdoctoral fellows.

In this paper, we present the accounts of these young women, ~~while~~ examining their considerations, and trying to untangle the impact of the context—their personal, professional, economic, and family circles—on their decision-making.

## II. INTERSECTING KNOWLEDGE FIELDS

The research that deals with the integration of women into academic careers is embedded in various academic disciplines, ~~which that~~ are mostly studied separately: psychology, sociology of education, sociology of organizations, gender studies, labor studies, economics, and more others. The starting point for our study lies in the understanding that the answers to complex questions about barriers to women’s integration within academia cannot be found in a single theoretical field or discipline. We must step go beyond these traditional disci-

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iplinary borders toward interdisciplinary research, which can provide a diverse and multidimensional perspective to examine and answer these research questions.

The lack of interdisciplinary research among those dealing with career issues and the need to integrate different perspectives have been highlighted as early as the 1970s [5]. The lack of interdisciplinary research in the field results in a partial and biased understanding of careers, and so a multilayered approach is needed [6].

In response to this challenge, we study career decision-making in physics as a multilayered and multidimensional phenomenon, combining in our analysis contextual, organizational, and individual variables and their intersection. Looking at both structure and agency, we do not view careers not as based solely on an individual's free choice, but rather on the intersection between the individual choice, the roles and structure of physics as a field (in terms of Bourdieu), the gendered social expectations and norms, and the expected family division of role and employment expectations.

### A. Gender and power

The understanding that power is an integral part of gender relations is central to the feminist theory [7–11]. Power is an integral part of Scott's definition of "gender" [10]: "According to Scott, according to which "gender is not only a constitutive element of social relationships based on perceived differences between the sexes, but it is also a primary way of signifying relationships of power. Changes in the organization of social relationships always occur concurrently with changes in representations of power."

The idea that social structure and processes are gendered was developed within the feminist discourse from starting in the early 1980s. Our theoretical starting point is based on the understanding that gender is a power structure in society, within the family, and in organizations [7, 10, 12–14].

In her book "Gender and Power" [7], Connell characterizes the elusive way in which power works in social relationships: "While particular transactions involving power are easy to observe, it is often difficult to see beyond individual acts of force or oppression to the structure of power, a set of social relations with some scope and permanence." This elusive social power may be "a balance of advantage or an inequality of resources in a workplace, a household, or a larger institution." Connell uses the term "gender regime" to analyze gender relations within the family [7, 14].

Acker claims that gender is a structural feature of labor organizations [13]. She proposes a theory of organizations and gender that follows Kanter [12] and other scholars [7, 10, 15] who claim that gender is a structural feature of organizations and not a characteristic feature of individuals bringing it to the workplace. Acker shows how deeply gender is embedded within organizations. She claims

that "the organizational structure is not gender-neutral. On the contrary, assumptions about gender underlie the documents and contracts used to construct organizations and to provide the commonsense ground for theorizing them." According to Acker, when we say that an organization is gender-biased, it means that advantage and disadvantage, exploitation and control, action and emotion, and meaning and identity are all patterned through and in terms of a distinction between male and female.

Following these insights, we claim that gender acts as a power structure in academia, within the field of physics as a space of knowledge production and as a workplace, and within the family. As such, it produces and reproduces the career choices of young women.

Gender studies have changed in the last three decades in many ways, with a growing recognition of feminist thought and activism in the Global South, and the development of queer studies and trans studies, mainly in the United States [16]. Moreover, there is a wide understanding now exists that gender should not be studied separately from other power structures. Therefore, the intersections of race, class, and gender have been widely accepted as an important aspect of feminist research and theory. The intersectionality perspective has developed from the critique of the hegemonic "white" feminist theory that was based on the experience of white women [17, 18]. Scholars now suggest new avenues to researching and publicizing the hidden stories at the intersections of race, ethnicity, gender, class, nation, and sexuality [18].

Upon examining the intersection between gender and ethnicity, one sees that class and religion are also very important in the Israeli context. The Israeli society is divided by aligned along two main axes: religion and ethnicity. There are social gaps between religious and secular Jews, between Jews and Arabs, and between the geographical and social periphery and the center, and these axes are interconnected and also influence women in academia as well [19]. The field of physics remains, however, a very homogeneous field, consisting mostly of men, white, Jewish, white male Jews of medium-high socioeconomic background, and coming from educated families [4, 20].

### B. Physics as a social field

Physics is a masculine field, characterized by the supremacy of a white male majority; it has a with masculine culture and a masculine public image of the field [21]. Women's integration of women into this field is relatively new, and the gender imbalance in the field is significant worldwide [3]. Following Bourdieu's theory [22, 23], we study physics as a social field. Social field, which is a patterned set of practices within a broader social space, which that suggests competent actions in conformity with rules and roles. It is a playground or battlefield in which actors, endowed with a certain field-

relevant capital, try to advance their position.

Traweek [24] conducted an in-depth anthropological study of the world of physics, tracing the culture of high-energy physicists in one of the leading laboratories in the USSA. Traweek describes physics as a male domain and claims that masculinity is an organizing principle of the physics laboratory, as part of the common perception that science is a field of “individual great men.” The field of physics is highly competitive. To be accepted as a member of the physics community, ~~you have to one must~~ be very committed, charismatic, highly motivated, dominant, and aggressive. Only the strongest and brightest manage to overcome these obstacles or, in her words, “Only the blunt bright bastards make it.” This culture of physics, as a male-dominated field, ~~was~~ is also prominent in later studies [21, 25].

One ~~of the~~ examples of the gendered nature of organizations lies in the common gendered perception of the “ideal worker,” which is based on an the image of a man who is free from the burden of ~~taking care of~~ childrencare and family and can therefore put devote his entire time and energy into work [13]. Acker claims that occupations and hierarchies assume a universal, intangible employee. This employee is, in fact, a man: a man’s body, masculine sexuality, control over emotions, and minimal responsibility for reproduction. Images of the male body and masculinity that are dominant in organizational processes marginalize women and contribute to the preservation of gender segregation in organizations.

This claim, which is certainly valid with regard to academic institutions, ~~which were~~ was established and took shape in an era when most staff members were men and most of their spouses were housewives. Bagihole and Goode [26] examine Acker’s claims in the context of academia. They argue that there is a standard model of an academic career. ~~This model that~~ is far from being gender-neutral. Instead, it is embedded in a masculine culture and based on a patriarchal support system. Bailyn [27] studied the academic careers of senior female faculty in at MIT. She argues that the belief, shared by women female and men male academics alike, is that the only way to be a first-rate scientist is to strive to be the ideal, perfect academic, for whom work is the total priority, and for whom there are no outside responsibilities and interests.

Benschop and Brouns [28], who examined gender aspects in academic institutions in the Netherlands, claim that in the basis of the scientific quality standard lies contains the “Olympus” model of science, in which the dominant representation of the brilliant researcher is that of a young man at the top of the Mount Olympus, away from the practices of daily life, rooted in the ivory tower of academia. This model is one-dimensional, gender-biased, not open to variance, and may alienate women who ~~do not find themselves in it~~ see that they do not appear in the model.

The perception of a profession as male masculine or female feminine is also influenced by the extent to which

an occupation allows or ~~does not allow~~ prevents one from to combineing family life with a career. ~~For women who completed a Ph.D. in Israel with an excellent grade, this component was found to be a significant factor in their decision-making of of women, who completed PhD in Israel with an excellent grade,~~ whether to pursue an academic career in science [29].

Lamont and Molnar [30] review the idea of “boundaries” and how it explains various inequalities such as class, race, and gender. ~~On~~ For the latter, their focus is on how gender and sexual categories shape expectations and work life. In this context, boundaries are defined as “the complex structures—physical, social, ideological, and psychological—which that establish the differences and commonalities between women and men, shaping and constraining the behavior and attitudes of each gender group” [31]. Violation of gender boundaries often leads to punishment and stigmatization in the workplace [32].

### C. Gender inequality

The attempt to understand the preservation of inequality in academia in general, and in sciences in particular (science, technology, engineering, and math, or STEM), has given rise to a growing body of research. Current explanations deal with the conscious and unconscious processes taking place that occur at the individual, organizational, and social levels.

These explanations can be divided into three categories: ~~E~~ explanations concerning the preservation of the gendered power structure in society, including in organizations, that is are also reflected in the field of science (see, e.g., Refs. [7, 13]), ~~E~~ explanations concerning organizational structures, processes, and practices in academia that are biased toward men, their way of life, and merits [33–35]; and ~~E~~ explanations concerning organizational culture and climate, which belong, to some extent, to the previous category, but are dealing more with conscious practices and behaviors that have a negative impact on women in academia (chilly climate, sexual harassment, and micro-aggressive behaviors toward women) [36].

In the organizational context, studies have found that the inequality in academia starts with recruitment and screening processes (the “similarity bias,” activation of criteria fitting men such as the number of publications, and recommendation letters in which containing gender bias against women is present); and continues further to include working conditions and job characteristics (women receive lower wages than their male colleagues, less fewer research resources, there is a funding is gender-bias in funding, in as are staffing resources, etc.); and further to a. Unequal practices also appear in the promotion process (promotion processes, which are biased in favor of men, and (e.g., the preservation of the “scissors curve,” in which the proportion of women decreases as the positions become more senior)

[29, 33, 34, 37–39].

#### D. Women’s career decision-making

Women pursuing non-traditional careers face many obstacles and constraints that can limit or impede their career development. Those who wish to pursue an academic career in masculine fields must often overcome the absence of role models, weak self-efficacy beliefs, and uncertain outcome expectations along with cultural and institutional barriers.

Previous research focusing on STEM fields in academia reveals a high attrition rate for women before and during their postdoctoral studies, a key period towards leading to an academic careers, where the numbers of women decreases dramatically [29, 40, 41].

Choosing an academic career path is a risky decision. The results from a meta-analysis of the research on 16 different types of risk-taking indicate that male participants are more likely to take accept almost all types of risks than are female participants, in almost all types of risks [42]. The tendency of women to take fewer risks may be one of the explanations of the lower rates of women who choose the academic path, given its high demands and job insecurity.

The decision by women to pursue a non-traditional career path such as physics, could be also explained (following Social Cognitive Career Theory (SCCT) [43, 44]) by their lower self-efficacy (on average). The belief of a low levels of self-efficacy in science beliefs among women pertaining to science have been implicated in contributing to the limited number of women earning post-graduate degrees and holding academic appointments [45–48]. Other factors that may explain a woman’s choice not to pursue a career in physics include the imposter syndrome, the lack of mentoring and advising during graduate school, and the “two-body problem” [49].

However, these theories and explanations for decision-making are, however, partial and share the same problems as other sociological or psychological theories of career decision-making (Trait Theory, the Developmental Model, and the Social Learning Theory, see Ref. [50]). All of these theories retain a strong sense in which decision-making is being fundamentally an individual process, it that can contains large major elements of technical rationality and it remains within the influence or the control of individuals [50].

Following Bourdieu and others, we claim that the career decision-making of women is affected by both their agency (i.e., their capacity of individuals to act independently of the social system and to make their own free choices) and context factors. The literature on decision-making may help to understand women’s considerations in choosing an academic career [51], but consent is never freely or neutrally given in situations of inequality [52].

Bourdieu’s field theory [50, 53–55] helps to better explain the power structures that influence women’s decision-making over regarding an academic career; it is helpful to use Bourdieu’s field theory [53–55] (see also [50]). According to Bourdieu, agents do not continuously calculate according to explicit rational and economic criteria. Bourdieu uses the agency-structure bridging concept of field. A, in which a field can be described as any historical, nonhomogeneous social-spatial arena in which people maneuver and struggle in pursuit of desirable resources. In his words, “it is the state of the relation of force between players that defines the structure of the field” [56]. The “players” within the field are various and they have different resources and power, which make up “the relation of force.” For Bourdieu, each stakeholder brings capital to the field, which can be economic, social, cultural, or symbolic.

But However, as we learned from decades of sociological studies, these various types of capital are all gendered, and gender operates as constitutes an asymmetric capital. Therefore, while masculinity operates in favor of men, femininity does not operate in favor of women [57]. Moreover, following Bourdieu’s theory, the recognition of the limits of what is possible or what is not possible, encapsulated in the decisions of men and women, shapes their aspirations and career paths in a different way. Women’s decision-making is shaped within a gendered power structure.

#### E. The Israeli context

In order to understand the research context, we would like to refer to the Israeli society, which has certain special characteristics.

First, Israeli-Jewish society is a familial society. The importance of family is manifested in the relatively high number of children per family, and in the great importance attached to the family in the life of both the individual and the community [58]. The family is a central social institution in the individual’s life and part of the national strength. As a result of the centrality of the family, is that the woman in the Israeli-Jewish family is perceived, first and foremost, as a mother and a wife, and only then next as a provider [59].

Israelis marry on average at a relatively young age and have more children than women in other Western societies. The average fertility rate per woman in Israel is 2.7 children per woman (for all women excluding ultra-orthodox Jews that, who hold have a higher rate), which is a high rate compared to with the overall average of 1.7 average in the OECD countries [60].

In Israel, most women are employed full-time; and most maintain a full-time employment history even during the years of while raising their children. The rate of full-time employment for women in Israel rate (68.2%) is much higher than far exceeds the corresponding rate in other countries, such as Germany (54%), Norway

(60%), the United Kingdom (57.7%), and the Netherlands (41.6%) [61].

However, despite the large extent ~~of to which~~ Israeli women's participation in the labor market, and despite a discourse that promotes equality in the division of roles in the domestic sphere, the division of roles within Jewish-Israeli families ~~is still remains~~ unequal, ~~which holds equally well, and~~ in most cases, for the burden of raising children ~~is not equal~~. ~~As found in r~~Research ~~conducted among on~~ Israeli fathers ~~found that, even though there has been despite the an~~ increase in recent decades in ~~the fathers' involvement by fathers~~ in household chores and childcare ~~practices~~, the parental responsibility ~~for in~~ the private sphere ~~is still remains unequal~~. ~~This sphere remains~~ feminine. Men spend longer hours at work, and most of the household chores and childcare become ~~their the burden of their~~ wives' burden [62]. These findings are in line with studies conducted in other Western countries (for example, in the USA and Canada; see, *e.g.*, Ref. [63]) and with the research on women working in male-centric domains, ~~that and who~~ experience daily battles ~~as between~~ competing desires to both be a "caretaker" at home and ~~to~~ develop a professional career [64]. Family transformation in Israel is influenced by two contradictory trends—preservation versus innovation—with each pulling in a different direction [65].

~~As for the integration of women i~~In STEM fields in the Israeli academia, women are ~~also~~ under-represented. The lowest representation of women is in ~~P~~physics, ~~with~~ only 6% of the academic staff in physics ~~are being~~ females [4]. ~~However,~~ the rates are ~~low~~ also ~~low~~ in mathematics and computer studies (11%); ~~the~~ physical and life sciences (13%), and ~~in~~ engineering and architecture (14%) [66]. Kark [67] claims that the under-representation of women in STEM fields in Israel is a consequence of the compulsory military service that is biased towards males, the social norms of familialism, and the gendered care responsibilities.

### III. METHODOLOGY

#### A. Mixed-methods research paradigm

~~In t~~This study, ~~we used~~ the mixed-methods research paradigm, ~~which is~~ an intellectual and practical synthesis based on qualitative and quantitative research. ~~The m~~Mixed-methods ~~research~~ recognizes the importance of traditional quantitative and qualitative research but also offers a powerful third paradigm choice ~~in order~~ to provide the most informative, complete, balanced, and useful research results [68–70]. In parallel, to structure the research tools and analyze the research findings, we used feminist research approaches and theories that provide ~~the~~ framework and tools for ~~looking delving~~ into ~~the lives of women's lives~~ [71–73].

Within ~~our mixed method~~ ~~mixed-methods~~ research,

this paper is based mainly on qualitative-data collection and analysis, ~~while although it~~ concurrently recognizing ~~es~~ that the addition of quantitative data and approaches ~~into~~ the research contributes to a rigorous understanding of the social phenomena ~~that we under~~ study.

#### B. Qualitative-data collection

~~In a~~ series of surveys we conducted in 2018–2019 ~~among of~~ all ~~undergraduate and graduate~~ physics students in Israel, ~~studying for a B.Sc., M.Sc. and Ph.D. degree, we found revealed~~ that these students belong to a hegemonic group ~~within the~~ Israeli society, consisting mostly of ~~white Jewish men, white, Jewish,~~ of medium-high socioeconomic background, and ~~coming~~ from educated families. Women ~~are form~~ a minority ~~among of~~ physics students in all degrees, ~~with and their rate has~~ hovering around 16% in all three degrees (B.Sc., M.Sc., and Ph.D.) ~~in over~~ the last decade. The number of Arab students is ~~very even~~ lower ~~close to at just under~~ 1% of the students ~~or less~~. Ultra-orthodox students are almost ~~completely~~ absent ~~in from~~ physics. Another variable examined was gender self-definition: The vast majority of physics doctoral students defined themselves as either "male" or "female" (only three students defined themselves as "other"), so we did not have a ~~sufficiently~~ large ~~enough~~ group to explore ~~in~~ this aspect [4, 20].

~~Hence Thus,~~ although we fully acknowledge the importance of examining the intersections between gender and other social categories, ~~as a consequence of the characteristics of given that the field of~~ physics in Israel ~~as a field that~~ lacks diversity in terms of religion, ethnicity, ~~gender,~~ and status, we focussed ~~herein~~ on examining the differences between women and men in physics as distinct categories.

The first stage of the research was qualitative. We conducted 25 in-depth interviews with female physics Ph.D. students studying at six research universities in Israel [74]. Given the small size of the community (~~there are~~ about 60 female physics Ph.D. students ~~are enlisted~~ in Israel in a given year), we had to reach out to many of them. The researchers communicated with the students first through an email request, ~~following which we then~~ used personal connections within the physics community and ~~the~~ snowball methodology to ~~achieve obtain~~ a high response rate. No student refused to be interviewed; some even agreed to be interviewed while ~~in~~ maternity leave. The interviews were conducted face to face in the students' offices ~~or~~ labs, and sometimes in their homes or at a coffee shop, ~~according depending to on~~ their request.

Overall, we interviewed 25 female physics Ph.D. students ~~The age of the interviewees ranged~~ from 26 to 36 ~~years of age~~. Most of them were married or in a relationship (21), and only a few were single (4). Twelve were mothers, with 1–4 children, mostly babies or toddlers. Fifteen were experimental physicists, and ten were theorists. ~~With regard to Ten of~~ their spouses ~~occupation, 10~~

were engaged in the fields of computers, engineering, or other “exact” sciences in the industrial or private sector, ~~Eight~~ were Ph.D. students in physics, ~~similar to their spouses~~, and the ~~other~~ remaining had ~~various~~ other occupations.

To understand the next phase of the academic career, the postdoctoral path, we also conducted 13 interviews with Israeli female postdoctoral fellows abroad. We reached out to them ~~by~~ through our social network within the physics community and by using the snowball methodology. Most interviews were conducted online (using Skype) while the scientists were abroad conducting their research. Most interviewees were in their mid-thirties, all of them were in a relationship, and ~~most~~ eleven of them (~~11~~) had children. The number of children ranged between one and four, with two being the most common. The majority were admitted to postdoctoral studies in leading institutions in the USA and Europe. Since we followed their career in the years following their research, we ~~can also~~ note that the post-doctoral duration for most of them ~~has been~~ was four years.

The aim of the interviews was to understand the individual and institutional factors impacting their career decisions, whether to pursue an academic career in physics or to leave the academia to ~~and take~~ a different career path. We listened to their description of their academic path, their choices, and their ability to create the future they desire.

All interviews with Ph.D. students and postdoctoral fellows were recorded, transcribed, and thematically analyzed using, ~~at~~ in the first stage, the ATLAS.ti software and, ~~at~~ in the second stage, a qualitative research analysis based on the “Grounded Theory” model [69].

### C. Quantitative-data collection

The second phase of the research included quantitative-data collection. ~~In order to~~ To have a broader, representative data ~~regarding~~ covering all physics graduate students, male and female, we conducted a nationwide survey.

The survey questionnaire was compiled by the research team in consultation with researchers at the American Institute of Physics (AIP), which has been researching student attitudes toward physics for a decade. The research questionnaire that was formulated is partly based on the tools developed at AIP for research in the field ~~but, while~~ adapting it to the Israeli context and to the research questions that interested us (see, for example, Ref. [75]). The questionnaire included 106 questions, ~~six~~ of which ~~6~~ were open-ended. The topics included: the students’ socio-demographic background, academic study track, attitudes regarding the academic environment, success indicators, the combination of family and studies, future employment expectations and intentions, the desire to have for an academic career, considerations in favor of and against postdoctoral studies, and

Institution	Students	Respondents	Response rate
Weizmann Institute	109	71	65%
Bar-Ilan University	67	50	74%
Hebrew University	65	40	62%
The Technion	65	39	60%
Tel Aviv University	64	39	60%
Ben-Gurion University	34	28	82%
<b>Total</b>	<b>404</b>	<b>267</b>	<b>66%</b>

TABLE I. Physics Ph.D. students in Israel: the overall population and the number of respondents by institution.

aspects of discrimination and sexual harassment during the academic studies. Some findings of the survey are beyond the scope of this paper and are reported elsewhere [76].

Physics graduate studies are only possible at a few universities in Israel. Therefore, to conduct their research, we reached out to the Israeli Physical Society (IPS) for partnership and support ~~in our study~~. Through the IPS, we were able to reach the six physics faculties in the Israeli universities that have with a Ph.D. track program in physics: Bar-Ilan University, Ben-Gurion University, Hebrew University, the Technion, Tel Aviv University, and the Weizmann Institute of Science. ~~Together with the~~ Shouldered by the IPS, we ~~approached~~ asked the six physics deans ~~and asked~~ for their help in distributing the survey. ~~Indeed~~, all ~~university deans of whom~~ forwarded the survey request to their Ph.D. physics students. The deans also shared with the research team their data ~~about~~ regarding the number of active students by gender. ~~Following the~~ The data collected ~~we were able to have~~ gave us the final numbers of physics Ph.D. students in Israel by gender: ~~of a total of N=404~~  $N = 404$  students, ~~of whom N=64~~  $N = 64$  were women and  $N = 340$  were men (in 2019).

To enhance the response rate, we promised all students full anonymity, distributed the survey through the faculties mailing lists, and reached out to students to encourage them to answer the questionnaire. ~~We also~~ As an extra incentive, we gave all participants a \$15 card to buy books ~~as a thank-you gift~~. We ~~managed to~~ received a ~~very~~ remarkably high response rate: ~~of 66%~~ of the overall population of students in the country (267/404), with ~~an even higher response rate~~ 94% for of the women responding (60/64); and 61% response rate for of the men (207/340). We received answers from students in all six universities. ~~Table I shows the~~ population size and response rate by institution ~~are presented in the Table I~~.

The maximum error for the entire population is 3.6%, or 3.2% for among women 3.2% and 4.3% among for men 4.3%. Due to the representation of women in the sample, the total data of the students was weighted by gender. ~~Given the small populations, the data were analyzed~~ was performed by using a proportion of vari-

ance to proportions analysis, [AU: Please verify, in particular, the red text to ensure that the intended meaning is maintained.] given small populations.

#### IV. FINDINGS

##### A. The postdoc as a “deal”

Exploring the student’s expectations of an academic career illustrates their image of the field. Within our nationwide survey, we asked all Ph.D. students that stated that they would pursue an academic career (143/248) the following open question: “If you are interested in an academic career, please elaborate why?” Their answers were somewhat surprising. We found that love for physics and a deep interest in this field were the most common answers (66) (*inter alia*, loves research, loves exploring, loves basic research, this is my dream, it fits my character). The next most common answer (33) was the academic freedom (the ability to conduct my own research, independence, no bosses or customers). The third most common answer (21) was related to the work conditions (favorable conditions, tenure, job security, prestige, social status, and leadership capacity).

All three reasons were also raised by the interviewees. We thus conclude that the main benefits of the academic career “deal” are the ability to engage in scientific research in a fascinating field, intellectual freedom to explore and be creative, independence in choosing what and how to do research, freedom from bosses and clients, and working conditions that guarantee employment stability and (reasonable) economic well-being. The deal does not include quick enrichment but it does include the prospect of groundbreaking scientific discoveries (and the concomitant worldwide fame alongside them), as well as the prestige that comes with being part of the exclusive club of the intellectual elite.

In light of these career benefits, we found that, at the crossroads of pursuing a postdoctoral appointment, the academic career is considered as a “deal” which with has three main components: personal-marital, professional-occupational, and financial. Young women are realistically examining the components of this deal: what it offers them and what prices they will have to pay. In Although a decision is made based accordance with these considerations, the decision is made. T, this does not imply that the considerations are all “rational” or “objective.” Undoubtedly, the decision involves feelings and thoughts, realistic and unrealistic expectations, perceptions of academic institutions and the labor market, and aspirations offor a professional and personal future; but. However, the bottom line is that all of the above are merged into one informed decision; of whether to go abroad for a postdoc abroad as a necessary step for an academic position, or to quit the academic race at the current stage.

Embarking on a postdoctoral career is a significant; and even dramatic step in the lives of young women (and men); and requires at the will to make significant changes in many aspects of their life for a long significant period of time. In order to obtain a tenure-track position in physics, two postdoctoral periods are often required, i.e., a cumulative period of about four years abroad. Therefore, it has brings with it personal, family, professional, and financial implications considerations for both women and men; and occurs under conditions of uncertainty and job insecurity. Women explore all of these aspects while when they examine the option of a postdoc.

On the personal and family level, relocation to a foreign country is required, which includes in many cases the need to integrate children into new schools and/or kindergartens while learning a new language; and integrating into a new social and cultural environment as well.

On the professional level, the candidate must find an academic mentor and an institution willing to host her for the postdoctoral period. This task requires talent, self-marketing skills, a willingness to travel abroad, and an effort to become acquainted with suitable scientists and institutions. During the postdoctoral period, the candidate is required to prove herself again, to publish, to make a good impression on the relevant professional community, and to prove her capability as an independent scientist. After all these efforts, the postdoctoral researcher is not guaranteed to get an academic job; as because competition for such jobs is high, and so the her chances are in this respect are unknown.

On the financial level, there is the concern for making a living. The typical scholarships during the postdoctoral period is pay significantly lower less than the average wage of a physicists’ average wage in the labor market. In addition, such scholarships does not include social benefits and the accrual of future rights, such as a pension and/or an education fund. Most scholarships are designed to allow a single person to live a modest life; and usually do not suffice for a family. The costs of living abroad for an Israeli family with young children may be significantly higher than the average postdoctoral scholarship; It which means that they have to fund postdoctoral studies viathrough savings or via family support, and this in a time of their lives when they are expected to be financially independent. Moreover, relocation abroad may impair the spouse’s income, employment continuum, and skills. For some professions, it is hard to find a parallel job abroad (for example, lawyers or military officers), and, in some cases, immigration-related restrictions do not allow the spouse to work.

All of these components are considered by the women and their spouses when making pondering the decision of whether to go abroad onfor postdoctoral studies.

## B. Gendered aspects of the deal

While both women and men both examine the terms of the deal—terms at a similar stage of their lives, it is clear that among, for women, the gendered power structure creates different expectations and extra hurdles, which make their decision to undertake for a postdoc more challenging.

The gendered power structure influences women’s academic careers in physics in numerous ways. First, women face unequal competition in physics as a masculine field. Second, couples tend to prioritize the man’s career over the woman’s career. Third, the postdoctoral career path is socially perceived as a disruption of the gender order. Women justify this non-normative path by demanding of themselves exceptionally high standards of academic excellence. We claim that these standards of excellence operate as a hidden component within the gender regime that justifies women’s the decision of women to go do for a postdoc.

### 1. Unequal competition in physics as a masculine field

As discussed in Section II B, physics is a masculine field, characterized by the supremacy of a white male majority, with a masculine culture and a masculine public image of the field. Thirty years after Traweek’s work [24], the field of physics is still remains masculine and highly competitive in many western countries, including Israel. The gendered labor market in the physics field is clearly reflected in both our survey findings and the interviews. Along Over the last decade, females have constitute accounted for only 16%–17% of the B.Sc., M.Sc., and Ph.D. physics students in Israel, and there is no sign for positive that these numbers will change. At the faculty level nationwide, females constitute only 6% of the overall staff in all physics faculties [4].

The marginal position of women in the field of physics is evident not only quantitatively, but also qualitatively, in the (see women’s the experiences, see of women in Table II). Most female Ph.D. students reported having experienced gender-based discrimination during their studies, compared to with only a small minority of men. Moreover, one in every five women reported being sexually harassed during their studies, compared to with one in forty among men. Of these women, half were harassed more than once, and only a minority of victims reported it to official entities. Similar findings in this regard were reported in Ref. [77], based on interviews with 21 women in graduate physics and astronomy programs: (F for a related study, see Ref. [78]).

As we found in from the interviews, in physics as a male-centric culture, the fact that women are different in the male-centric culture of physics plays against them, and the disadvantage becomes more prominent when they become parents. While women are expected to

become the main caregivers, their men male colleagues are expected to follow their career as they had done before they became coming parents. Timing works to the detriment of women since because, while although they need flexibility in order to raise young children, they have to prove themselves to a highly demanding system that does not stop for a moment [79], a system in which there is no such thing as a “good” time to have children.

Although many of the women we interviewed said that they strive to implement an egalitarian model of childcare at home, most of them also report they spent longer hours in childcare and child-related work compared to with their partners, and that this comes at the expense of their studies.

These findings are supported by the survey data that indicate that, despite of at the prominent presence of an egalitarian ideology among physics student families, expressed by the desire of both the women’s and the men’s desire for an equal distribution of roles, it is evident that the women inevitably carry a greater burden of family work. First, they take a longer maternity leave, a period of time that which impedes their studies: Most women take a maternity leave of 4 four months or more, compared to with a very short parental leave used taken by the male students. See Table III for the full survey results. As apparent from the interviews, women are must also going through the pre-birth period, during which many women need must to undergo various examinations; and sometimes require medical care and observation, which take require time and require a lot of medical attention (a reality that may also repeat itself after the maternity leave as well).

Second, women, reported more than their male colleagues, reported that, due to parenthood, they adopted a more flexible work schedule, and that they learned to be more productive in their studies. See Table IV for the full survey results.

Third, examination of the role-distribution structure in these families indicates that, although the fathers are engaged in childcare, there is still gender inequality remains at home (see Table V). 100% of All the women reported that they are responsible for taking care of their children’s needs, either as the primary caretaker, or by sharing childcare equally with their spouse equally. In contrast, while the majority of men reported that they share the childcare responsibility with the spouses, more than a quarter reported that most childcare responsibilities are imposed fall on the shoulders of their spouses, and only a small minority reported to bearing most of this the childcare responsibility.

Moreover, although most women and men (67%) reported that they share household chores, none of the women is were free from this burden (the remaining 33% of women reported that the household burden mostly lies on their shoulders), while whereas men either share the burden with their spouses or it is falls mainly imposed on their spouses. See Table V for the detailed results.

These findings are not surprising: They are have been



Topic	Female	Male	$P$
	Yes/Total (%)	Yes/Total (%)	
Have you experienced gender-based discrimination?	34/54 (63%)	5/167 (3%)	<0.01
Have you been sexually harassed during your studies?	13/59 (22%)	5/204 (2.5%)	<0.01

TABLE II. **S**Results of survey **r**esults on the issues of gender-based discrimination and sexual harassment.

Duration	Female $n(\%)$	Male $n(\%)$
	( $n = 21$ )	( $n = 93$ )
$\leq$ week	1 (5%)	61 (66%)
Week-month	0 (0%)	28 (30%)
1-3 months	5 (24%)	4 (4%)
$\geq$ 4 months	15 (71%)	0 (0%)

TABLE III. **S**Results of survey **r**esults on for the following question: What is the duration of the maternity leave you took after the birth of your last child?  $\chi^2 = 92.67$ ,  $P < 0.00001$ .

	Female $n(\%)$	Male $n(\%)$	$P$
	( $n = 18$ )	( $n = 89$ )	
Reduced time for study	15 (83%)	64 (73%)	< 0.05
More flexible schedule	12 (67%)	42 (48%)	
More efficiency	8 (44%)	24 (27%)	
Reduced pace of studies	7 (39%)	30 (34%)	
No change	1 (6%)	12 (14%)	

TABLE IV. **S**Results of survey **r**esults on for the following question: How did your course of study change as a parent?

manifested in studies about time spent on housework and childcare in western democracies for decades. According to the American time-use survey, women spent an average of 2 hours and 15 minutes a day on housework, while whereas men spent 1 hour and 25 minutes [80]. Women continue to take the primary responsibility for home and family even in some of the most gender-equal countries [81].

This gendered role division at home is reflected in the academia, by the more significant greater presence of men than women at physics labs and offices; in terms of time allocation. Most male physicists (even if they truly honestly believe in gender equality) do not practice parenthood in the same way as women. Although most male Ph.D. male students declared that parenthood affected their studies, parenthood is not as significant a variable in their lives as employment because they follow the social expectation that the family will be pushed aside due to by their career demands. At the same time, the usual typical expectation from of the Israeli women is to do be both, to be both dedicated mothers and career women.

The interviews show that women’s greater commitment to family makes it harder for them to succeed in their studies within a male-dominated culture. The young females women report being discriminated against based on the normative assumption that mothers are less competent and committed than other types of workers, as was documented in previous research addressing the “motherhood penalty” phenomenon [82].

T., a mother of a two-year-old girl who was pregnant at the time of the interview, told us about the difficulty of combining studies with motherhood. T. aspires to an academic career but, at the same time, she gives high priority to her family. She tries to live up to the social expectation of her “doing both.” She finds out that this situation puts her at a disadvantage in her daily competition with her male counterparts. Her commitment to family, or what she calls “this problem,” is her problem, and not a problem of her colleagues, all of them male and free from having to live up to the expectation of being the main caregivers for their children. T. describes it in a tone of acceptance, but also criticizes it:

“My family, my husband, my marriage, and my children are very important for me; they are very high in my priorities. . . . I feel the gender differences (compared to male colleagues) mainly since I have much less time to work than my friends from the lab, and it becomes a big gap. . . . it’s like you are competing against those to whom you compare yourself, all the time. . . . It’s hard to combine motherhood with anything that is career-related, not only in academia, but the competition is a competition with men who don’t have this problem.”

As a young mother, the difficulty of combining career and motherhood requirements becomes clear to T. Taking care of her two-year-old daughter takes precious time and harms hinders her ability to successfully compete with other students, and her lab colleagues, whose time is at their disposal and are less challenged by family demands.

The women’s experience is structured within a gendered labor market, where men and women have to live up to the same expectations at work, in the public sphere, but have different expectations at in the private sphere. Women’s understanding that physics as a field is gendered, that the competition in which they are competing and will be required to compete, is unequal, and that their challenge is to be both a mother and a career woman, leads some of them to quit the academic career race. Those who stay in the race understand that they must succeed in these gendered conditions, while com-

Topic	Female $n(\%)$			Male $n(\%)$			$P$
	Student	Equally	Spouse	Student	Equally	Spouse	
On whom lies the main responsibility of childcare?	12 (57%)	9 (43%)	0 (0%)	5 (5%)	61 (66%)	26 (28%)	<0.01
On whom lies the main responsibility of <u>the</u> household?	7 (33%)	14 (67%)	0 (0%)	11 (12%)	61 (64%)	23 (24%)	<0.01

TABLE V. SResults of survey results on the issues of childcare and household.

	Female $n(\%)$ ( $n = 58$ )	Male $n(\%)$ ( $n = 189$ )
Married	37 (64%)	132 (70%)
Children	20 (34%)	77 (41%)
$\geq 2$ children	10 (17%)	44 (23%)

TABLE VI. Family status of the survey respondents.

peting from an unequal starting point with those who are free from the “second shift<sup>2-</sup>” at home.

## 2. Prioritizing family and husband’s career

In Israel, in comparison towith other Western democracies, students in Israel start academic studies relatively late and marry at a relatively young age. Therefore, the family situation of Ph.D. students’ family situation in Israel has unique characteristics.

Based on theour survey of Ph.D. student surveys, male and female Ph.D. students in physics are in their early thirties. The average age is 29.7 among women and 31.8 among men. Most women and men are already married or in a relationship, and more than a third of them already have children. Moreover, about 23% of male and 17% of female Ph.D. students have two children or more. See Table VI for details.

This picture is clearly reflected in the interviews. Most of the Ph.D. students we interviewed (21 out of 25) already had spouses, half of them (12) were already mothers of young children at the time of the interview, whileand the single women declared their desire to become mothers in the coming years.

The majority of the spouses of the female students we interviewed were working in STEM fields (for example; engineers and computer scientists) or were graduate students in STEM fields. Most of the female students described their spouses as mostly supportive in their career aspirations and decisions, wanting and willing to help them succeed. In the survey, many students described their spouse as one of the factors for their own success ([89% of women (42/47) and 80% of men (124/155),  $p < 0.01$ ]). However, the interviews clearly indicate that, once there is a spouse enters the picture, career and family considerations become intertwined and therefore more complex. Career becomes “spousal<sup>2-</sup>” in the sense that a

decision made with regard to the man’s career affects the woman’s career, and vice versa. The couple is must considering the impact of their choices on the entire family.

The interviews with bothfemale Ph.D. students and female postdocs female—students prominently showed without a doubt that women give a significant weight to the implications on their spouse’s career of goingdoing for a postdoc on their spouse’s career. Women are preoccupied with the questions: Will my spouse be able to find a job or a postdoc abroad (in view of language- and visa-related barriers)? Will he be able to find work abroad that fits his skills and ambitions (depending on his professional characteristics, job availability, his ability to adapt to a different job market, etc.)?

A clear example of a “spousal<sup>2-</sup>” career and interrelated career considerations emerges from the story of S., married with two toddlers. S. and her husband are both Ph.D. students at the last stage of their studies. S. found it difficult to separate her career aspirations from her partner’s aspirations, which she presented as interdependent. The interviewer tried to refine the differences and understand what she wanted:

Q: “I’m trying to understand how you see your career, if you didn’t have any limitations, where would you like to see yourself?”

A: “Now, it seems that my doctorate is going to be more or less successful, and I’ll have good results, so yes, I would like to continue in academia and do a postdoc, and I know that there isare some institutions in Europe... they are looking for people (in our field) and we can both get work there, some sort of a postdoc, so that could be nice. But now it comes to my husband and if he finds a place that he will really love, and there won’t be a place for two people there, I’ll go look for a job in high-tech or something else, and that would also be perfectly fine, and if I won’t find a job in high-tech, I will be a teacher and it will also be fun... It won’t be as interesting as research, but it’s a job.”

S. clearly subordinates her desires to go forundertake a postdoc in physics to thoseat of her spouse; his career is clearly being given a clear priority within the spousal relationship, although her Ph.D. was good, and she recently won an award for excellence award.

In another case, the counterweight to a postdoc was the spouse’s desire to stay in Israel. B.G. is freshly married, and pregnant with her first child. She told us that her spouse supports her, but at the same time he does not want to leave Israel and is very connected to his country and his family. B.G. eventually decided to leave

academia. It is impossible to determine if it was her spouse who ~~affected~~led to the decision against a postdoc, but it was clear that his will ~~had~~carried significant weight in her decision.

~~R~~The survey results reinforcement of the findings that emerged from the interviews ~~is found in the survey~~. While both men and women reported that their spouse's employment considerations play a key role in their decision of whether to go for a postdoc, women have given more weight to this issue. Similarly, a higher percentage of the women indicated that their spouse's ability to find a job abroad was a key consideration, and a higher percentage of women noted as a key consideration the difficulties involved in relocating abroad with the spouse and family ~~as a key consideration~~. See Table VII for the full survey results.

Thus, it ~~seems~~appears that, even if the ~~male spouse~~husband is supportive and willing to follow the womanhis wife abroad, women give greater weight to histhe career, desires, and preferences of their husbands. This reflects, ~~inter-alia~~inter alia, the gendered power structure that exists within society ~~as well as~~and in the job market.

The priority and precedence given to the man's career in many families could be based on the understanding of their better chances for higher wages and promotion (in average) at the job market. It was surprising to find that, even at this early stage, when most students live on a modest subsistence scholarship, ~~there are~~already financial gaps in income, already in favor of the men. The majority of female Ph.D. students indicated that their spouse's income from school or work is higher ~~that~~exceeded their own income, compared with a minority of male Ph.D. students. See Table VIII for the detailed results.

### 3. Postdoctoral career path as a disruption of the gender order

In the Israeli context, there it is ~~a~~essentially requirement d to undergotake for postdoctoral studies abroad, ~~i.e.~~which means that the student must leave the country for a prolonged period of professional research and development. (The requirement is not formal, but the probability of getting an academic position after a postdoc in Israel is much lower.) Although the common view in contemporary educated circles is that the job market is open and equal for women, the interviews reveal a much more conservative view. ~~It is evident that~~tThe social and family environment clearly perceives postdoctoral studies as an ambitious and non-normative path for women. It is common for women to follow their spouses for a period of work or studies abroad, but the opposite model is still considered non-normative and is perceived as "feminist?" and challenging the common social order, in which the male career is the lead.

Consider more examples: Ts. iswas about to embark on a prestigious postdoc in the USA with her husband. She describes d the postdoctoral path as non-normative for a woman, which is why it hasd to be negotiated with her spouse and be justified against the family system:

"I think a postdoc abroad takes a heavy toll. Usually, the husband is older and has a job, and does not want to leave. The easy cases are when the husband also goes for a postdoc, or can work abroad and, in such a case, he wants to leave. Even if the husband is supportive, the broader family wrinkle up their noses and put pressure on me (not to go on a postdoc abroad). If it were possible to do a postdoc in Israel, it would be much easier for women."

M., a single, Ph.D. student, believes that women are less likely to go for a postdoc because it is a deviation from the conventional structure of gendered power relations. In the accepted social order, a man's career is the significant one, and not the other way around:

"I think that the cultural perception, at least in Israel, is that the woman will follow the man, ~~i.e.~~i.e., if the man has to relocate due to work or studies, it is perceived as more natural for the woman to follow him."

M. says the postdoc issue has coame up in her previous relationship, and although her former boyfriend's attitude regarding this issue was positive, his social environment was against this move and regarded it as non-normative. The idea of him, a man, relocating abroad for the benefit of his girlfriend's career, was met with criticism and astonishment by his colleagues.

The power structure in the job market that emerges in interviews reflects the patriarchal structure of society and power relations within the family. When a man follows his wife abroad, it disrupts the gender order. The priority given within the family to the ~~male spouse's~~husband's career restricts women from embarking on a postdoc and limits their choice of academic career.

This gendered power structure is so ~~profound~~deeply rooted that it even affects single women, ~~who do not have a spouse with no~~and children. Three single Israeli singlefemale Ph.D. Students whom we interviewed claim that they refrained from embarking on postdoctoral studies, ~~inter-alia~~inter alia, due to the concern that they may impair their chances to get married in the future or that it may create potential limitations on a future (spouse's) career.

### 4. Self-expectations for excellence: A hidden component in the gender power structure

As found in previous studies, women must demonstrate ~~stronger~~greater abilities than men in-order to be recognized as equally good. ~~For women to be considered good and worthy of employment and promotion in male-dominated disciplines, for women to be considered good, worthy of employment and promotion;~~ they must be better than their male peers [83, 84].

	Female $n(\%)$ ( $n = 41$ )	Male $n(\%)$ ( $n = 127$ )	$P$
Spouse’s employment possibilities	39 (95%)	114 (89%)	
Spouse and family relocation	38 (93%)	107 (84%)	<0.05
Putting the spouse’s career on hold	37 (90%)	99 (78%)	<0.05
Funding	37 (90%)	126 (99%)	<0.05

TABLE VII. Survey results on the following question: If you are considering going abroad for a postdoc, how central is this consideration in your decision?

	Female $n(\%)$ ( $n = 37$ )	Male $n(\%)$ ( $n = 134$ )
Higher than mine	25 (67%)	37 (28%)
Similar to mine	8 (22%)	27 (20%)
Lower than mine	4 (11%)	61 (46%)
Has no income	0 (0%)	9 (6%)

TABLE VIII. [SResults for urvey results on](#) the following question: Compare your spouse income to yours.  $\chi^2 = 24.48$ ,  $P < 0.00001$ .

In a gendered workforce, when women compete over an academic career in a masculine field, having to overcome gender discrimination and [the](#) motherhood penalty, prioritizing their husband’s career at home, and taking a greater share of the childcare, what justifies their decision to go on a postdoc abroad, or to embrace the academic deal?

Based on our research [findingsresults](#), we claim that, to justify this deviation from the “gender order”, women [are](#) pushing themselves to excel. Excellence was [broughtsingled](#) out as a justification that allows deviation from the norm and disruption of the gender order. Many women stated that it is considered [obviousnormal that](#), when a man goes [abroad](#) for a postdoc, [and](#) his wife goes with him, even if it requires [that sheher to](#) gives up her career. In contrast, for a woman to embark on a postdoc with her partner joining her, special conditions must be met. One of the unspoken conditions, mentioned repeatedly [alongduring](#) the interviews, is being an excellent student. This is how B.G., married and pregnant, explains why she decided to leave academia for a job in the industry after completing her Ph.D.:

“Women are also affected by their partner, not that men are not, but to a certain extent, when a man thinks about going for a postdoc, his wife is excited to follow him... it’s an adventure. [\(On the contrary,\)](#) a woman waits to hear the man’s opinion, and if he says no, then there should be a really good reason, for example, when (your) doctorate is brilliant and the supervisor wants you to travel for postdoc... then, maybe then.”

To deviate from the norm, the woman must be excellent. It is not enough for her to be a good or even a very

good student, and she probably cannot afford a postdoc if she is an average student. The excellence must be reflected in numerous aspects that are interconnected: her academic achievements, her supervisor’s evaluation of her, the professional group perception of her academic potential, and her ability to receive [a postdoctoral](#) offer from a top institute.

Excellence has two functions: [one](#) in the public sphere and [one](#) in the private sphere. In the public sphere, excellence allows the students to feel worthy to face professional competition [againstfrom](#) their male colleagues. In the private sphere, it justifies (to the spouses and to the women themselves) their choice of a non-normative career path for a woman, which includes going abroad for a postdoc and subordinating the family [in-accordance withto theirher](#) career needs.

A [very](#) clear example of excellence as a justification for disruption of the gender order comes out from the story of A., recently married with a baby. A. said she had already decided when she started her Ph.D. [studies](#) that she would not pursue a postdoc in a place that is “not good”. She says that, in the beginning of [their](#) relationship, [she and](#) her husband [and she](#) agreed that she would pursue postdoctoral studies if she were accepted into a prestigious institution. In return, he promised that he would be willing to leave his job to support her career. [ThisThe following](#) is her answer to the question of whether she would like to embark on postdoctoral studies abroad:

“Yes, very much! But it is contingent upon me getting a good postdoc! I mean, not a postdoc from the University of Nowhere, I don’t know, something like that, it should be a good postdoc! Because basically, my husband will come with me and will have to take a leave without pay, which is also not so trivial at work... I won’t drag the entire family if it’s a postdoc that will get me nowhere, you know, it should be a good and lucrative postdoc, so I would have some motivation to return to Israel. I really want to be in academia, and I think that science is just the best thing there is, in my opinion, and it’s something I want to do all my life.”

Another example [risescomes](#) from the story of V., married and mother of three, who is about to graduate. She shares her doubts about the future. [She and](#) claims her spouse supports her postdoc aspirations; however, if they relocate, he would have to give up a job that is a

significant part of his life. Therefore, for V., going for a postdoc ~~takes costs~~ a high price ~~for in terms of~~ her partner's career. After some deliberation, V. decided to do her first postdoc in Israel. Only if it is successful will she ~~will~~ go abroad for another ~~period~~ postdoc.

An academic career is viewed by the social and family environment not only as a highly demanding and competitive path, but also as a masculine, non-normative path for ~~a woman, by the social and family environment~~. Women in physics understand that they must compete under unequal conditions of a gendered labor market, and that they must excel ~~in order~~ to be perceived as equal. Under these conditions, excellence operates as a hidden component, ~~within the unseen gender regime,~~ that justifies and allows deviation from the gender order by going for a postdoc abroad and prioritizing a woman's careers over ~~their~~ husband's career.

~~Whereas for married men, m~~ Motivation is all they that ~~is needed for a married man~~ to go for a postdoc abroad, whereas motivation alone is insufficient for women ~~motivation is not enough to attempt the same~~. Married women need a very good justification for their non-normative career choice and for their husbands to follow them. This might be one of the dominant reasons for the low number of women pursuing an academic career in physics and the gender imbalance in the academic staff ~~in of~~ physics departments.

## V. SUMMARY AND DISCUSSION

~~In t~~ This study, ~~we used~~ a nationwide survey, ~~as well as~~ and in-depth interviews with female physicistss students as a robust empirical basis to explore ~~women the~~ decision-making process of women in physics at the crossroad of an academic career. We study career decision-makings in physics as a multilayered and multidimensional process. The theoretical novelty that we ~~suggest propose~~ is to viewing this process as a deal<sup>22</sup>, ~~which that~~ involves contextual, organizational, and individual variables, and their intersection. Young women ~~are~~ examining the components of this deal: what it offers them and what prices they will have to pay, but their decision is made within a gendered power structure. Studying both context factors and agency, we find that ~~the an~~ academic career in physics offers a deal<sup>22</sup> ~~which has it h~~ three main components: personal-marital, professional-occupational, and financial. Young women ~~are~~ realistically examining the terms of this deal, <sup>22</sup> what it offers them, and what prices they will have to pay. Their decision is made in accordance with these considerations, but, contrary to men, women ~~are must~~ operating within a gender power structure that navigates responds to their decisions in a different way.

While both women and men consider the terms of the deal<sup>22</sup> terms in a similar stage of their lives, ~~among the women,~~ the gendered power structure creates different expectations among the women and extra hurdles, which

makes the decision to pursue an academic career and to ~~go undertake for~~ a postdoc more challenging. Our findings reveal the multiple and hidden ways in which gender operates as a power structure in the labor market within for physics as an academic field, in the family within the private sphere, and ~~in within~~ the social norms and expectations ~~within of~~ society, putting up a considerable barrier to women's academic careers.

This latent power structure influences women's decision-making and experiences in several ways. In the academic field, it produces unequal competition in a male-dominated playground, where women struggle to succeed as physicists and as mothers, but are viewed as less devoted workers because of their parental commitment. Within the private sphere, women carry a greater share of the childcare and family work and, moreover, give priority and precedence to their husband's career and preferences. In the social sphere, choosing a demanding academic career is seen as a non-normative trajectory for women and as disrupting the gender order.

Women justify this non-normative path by raising their self-expectations for excellence. They feel that they must excel in their research and exhibit exceptional achievements. We claim that excellence operates as a hidden mechanism within the gender regime that can not only justify a woman's decision to ~~go for undertake a~~ postdoc, but ~~can~~ also operate as an exclusionary mechanism that prevents many talented young women from choosing an academic career in physics. We should thus stop thinking about women ~~as~~ giving up ~~the~~ academic careers ("the leaky pipeline"<sup>22</sup> discussion; see, e.g., Refs. [85, 86]) but rather ~~as think about~~ choosing career paths that align better with the gender regime within diverse social and cultural contexts.

Our acquaintance with the physics culture in the USA and in Europe, ~~as well as and~~ our close collaboration with the community ~~that conducts research on~~ gender in physics in the European academy (particularly the GENERA network [87]), lead us to believe that many of the main findings of ~~our this~~ research and our accompanying theoretical arguments apply not just only to physics in Israel, but also more universally, at least in the context of physics in western countries. The unique features of ~~the~~ Israeli society are helpful in making amplifying some aspects of examining the factors that affect the decisions involved in accepting the deal offered by a career in physics career as a deal stand out more clearly. Further research is needed, however, to support these findings and to explore hidden barriers ~~to the hinder the~~ integrating on of women into academic careers, in physics and in other scientific disciplines where they ~~still also~~ constitute a token minority.

If we want ~~the~~ academia to be more gender-balanced so that women are no longer a token minority, we should tackle the many obstacles women face, both in physics as a field and within the family circle. We should make physics more appealing ~~for to~~ women, knowing that their choices are made within a gendered structure and that

the academic path is more demanding for them. If academia does not act in this direction, it will lose talented females to the global technology companies, which in recent years have made intensive efforts to change the gender balance among their employees and integrate more women into diverse work teams.

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- [1] A.M. Porter and R. Ivie, *Women in Physics and Astronomy, 2019*, Technical Report, AIP Statistical Research Center (2019).
- [2] J. Blue, A.L. Traxler and X. Cid, *Gender Matters*, *Physics Today* 71(3), 40 (2018).
- [3] C. Singh, G. Cochran and N. Wilkin (Eds.), *Women in Physics: 6th IUPAP International Conference on Women in Physics*, AIP Conference Proceedings, Vol. 2019.
- [4] M. Eran-Jona and Y. Nir, *Women in physics in Israel: An overview*, in *Women in Physics*, 6th IUPAP International Conference on Women in Physics (AIP Publishing, New York, 2019).
- [5] J. Van Maanen and E.H. Schein *Toward a theory of organizational socialization*, *Research in Organizational Behavior* 1, 209 (1977).
- [6] K. Chudzikowski and W. Mayrhofer, *In search of the blue flower? Grand social theories and career research: The case of Bourdieu's theory of practice*, *Human relations* 64(1), 19 (2010).
- [7] R.W. Connell, *Gender and power: Society, the person and sexual politics* (Stanford University Press, 1987).
- [8] N. Hartsock, *Rethinking modernism: minority vs. majority theories*, *Cultural Critique* 7, 187 (1987).
- [9] A. Komter, *Gender power and feminist theory*, in K. Davis, M. Leijenaar and J. Oldersma.(Eds.), *The Gender of power* (London: Sage Publications, 1991).
- [10] J.W. Scott, *Gender: A useful category of historical analysis*, *The American Historical Review* 91(5), 1053 (1986).
- [11] D.L. Sheppard, *Organization power and sexuality: the image and self-image of women managers*, in J. Hearn., D.L. Sheppard, P. Tancred-Sheriff and G. Burrell (Eds.), *The sexuality of organization* (London: Sage Publications, 1989).
- [12] R.M. Kanter, *Men and women of the corporation* (New York: Basic Books, 1977).
- [13] J. Acker, *Hierarchies, jobs, bodies: A theory of gendered organizations*, *Gender and society* 4(2), 139 (1990).
- [14] R.W. Connell, *The State, gender, and sexual politics: Theory and appraisal*, *Theory and Society* 19, 507 (1990).
- [15] B.F. Reskin and P.A. Roos, *Status hierarchies and sex segregation*, In C.Boss and G.Spitz (Eds.), *Ingredients for women's employment policy* (Albany: SUNY Press, 1987).
- [16] R. Connell, *New maps of struggle for gender justice: Rethinking feminist research on organizations and work*, *Gender Work and Organization* 26, 54 (2019).
- [17] J. Acker, *Inequality Regimes: Gender, Class, and Race in Organizations*, *Gender and Society*, 20(4), 441 (2006).
- [18] E. Holvino, *Intersections: The Simultaneity of Race, Gender and Class in Organization Studies*, *Gender, Work and Organization* 17(3), 248 (2010).
- [19] N. Toren, *Mizrahi women in academia: Gender, ethnicity and social status*, in R. Herz-Lazarowitz and I. Oplatka (Eds.), *Gender and ethnicity in the Israeli academy* (in Hebrew) (Pardes Publications, 2009).
- [20] M. Eran-Jona and G. Perez, *What can the "Start-Up Nation do to enhance diversity in physics?*, Weizmann Institute of Science research report (2020).
- [21] A.J. Gonsalves, A. Danielsson and H. Pettersson, *Masculinities and experimental practices in physics: The view from three case studies*, *Phys. Rev. Phys. Edu. Res.* 12, 020120 (2016).
- [22] P. Bourdieu, *Outline of a theory of practice* (Cambridge, MA: Cambridge University Press, 1977).
- [23] P. Bourdieu, *The forms of capital*, in J.G Richardson. (Ed.), *Handbook of theory and research for the sociology of education* (New York: Greenwood, 1986).
- [24] S. Traweek, *Beamtimes and lifetimes: the world of high energy physicists* (Harvard University Press, Cambridge, MA, 1988).
- [25] K.L. Lewis, J.G. Stout, S.J. Pollock, N.D. Finkelstein and T.A. Ito, *Fitting in or opting out: A review of key social-psychological factors influencing a sense of belonging for women in physics*, *Phys. Rev. Phys. Edu. Res.* 12, 020110 (2016).
- [26] B. Bagilhole and J. Goode, *The contradiction of the myth of individual merit, and the reality of a patriarchal support system in academic careers: A feminist investigation*, *European Journal of Women's Studies*, 8(2), 161 (2001).
- [27] L. Bailyn, *Academic careers and gender equity: lessons learned from MIT*, *Gender, Work and Organization* 10, 137 (2003).
- [28] Y. Benschop and M. Brouns, *Crumbling ivory towers: academic organizing and its gender effects*, *Gender, Work and Organization*, 10(2), 194 (2003).
- [29] A. Gofen, *Academic career of graduates with excellent grades in SET fields 1995-2005*, research report of the Federman School of Public Policy and Government (2011).
- [30] M. Lamont and V. Molnar, *The study of boundaries in the social sciences*, *Annu. Rev. Sociol.* 28, 167 (2002).
- [31] J.M. Gerson and K. Peiss, *Boundaries, negotiation, consciousness: Reconceptualizing gender relations*, *Social Problems* 32(4), 317 (1985).
- [32] C.F. Epstein, *Border crossings: The constraints of time norms in transgressions of gender and professional roles*, In: C.F. Epstein. and A.L. Kalleberg (Eds.), *Fighting for time: shifting boundaries of work and social life* (New

- York: Russell Sage Foundation, 2004).
- [33] J. Gvozdanovic and K. Maes, *Implicit bias in academia: A challenge to the meritocratic principle and to women's careers - And what to do about it?*, LERU advice paper (2018).
- [34] D. Atewologun, T. Cornish and F. Tresh, *Unconscious bias training: An assessment of the evidence for effectiveness* (Manchester, UK: Equality and Human Rights Commission, 2018).
- [35] A.A. Eaton, J.F. Saunders, R.K. Jacobson and K. West, *How gender and race stereotypes impact the advancement of scholars in STEM: Professors' biased evaluations of physics and biology post-doctoral candidates*, Sex Roles 82(5), 127 (2020).
- [36] P.A. Johnson, S.E. Widnall and F.F. Benya (Eds.), *Sexual harassment of women: climate, culture, and consequences in Academic sciences, engineering, and medicine* (National Academies of Sciences, Engineering, and Medicine .Washington, DC: National Academies Press, 2018).
- [37] S. Kulis, D. Sicotte and S. Collins, *More than a pipeline problem: Labor supply constraints and gender stratification across academic science disciplines*, Research in Higher Education 43, 657 (2002).
- [38] J.S. Long (Ed), *From scarcity to visibility: Gender differences in the careers of doctoral scientists and engineers* (Washington, DC: The National Academies Press, 2001).
- [39] N.H. Wolfinger, M.A. Mason and M. Goulden, *Problems in the pipeline: gender, marriage, and fertility in the ivory tower*, The Journal of Higher Education 79(4), 388 (2008).
- [40] M. Goulden, K. Frasch and M.A. Mason, *Staying competitive: patching America's leaky pipeline in the sciences*, Berkeley Center on Health, Economy & Family Security and the Center for American Progress report (2009); *Keeping women in the science pipeline*, ANALS, AAPSS 638 (2011).
- [41] R. Carmi et al., *The team for examining the situation of women in the academic staff of high education institutes - report and recommendations*, The Israeli Council for Higher Education (2011).
- [42] J.P. Byrnes, D.C. Miller, and W.D. Schafer, *Gender differences in risk taking: A meta-analysis*, Psychological Bulletin 125(3), 367 (1999).
- [43] R.W. Lent, S.D. Brown and G. Hackett, *Toward a unifying social cognitive theory of career and academic interest, choice, and performance*, Journal of Vocational Behavior 45, 79 (1994).
- [44] A.M. Kanny, L.J. Sax and T.A. Riggers-Piehl, *Investigating forty years of STEM research: How explanations for the gender gap have evolved over time*, Journal of Women and Minorities in Science and Engineering 20, 127 (2014).
- [45] M.M. Chemers, L.-t. Hu and B.F. Garcia, *Academic self-efficacy and first year college student performance and adjustment*, Journal of Educational Psychology 93(1), 55 (2001).
- [46] R.W. Lent, F.G. Lopez and K.J. Bieschke, *Mathematics self-efficacy: Sources and relation to science-based career choice*, Journal of Counseling Psychology 38(4), 424 (1991).
- [47] M.L. Grunert and G.M. Bodner, *Finding fulfillment: women's self-efficacy beliefs and career choices in chemistry*, Chemistry Education Research and Practice 12, 420 (2011).
- [48] N.A. Falk, P.J. Rottinghaus, T.N. Casanova, F.H. Borgen and N.E. Betz, *Expanding women's participation in STEM: insights from parallel measures of self-efficacy and interests*, Journal of Career Assessment 25(4), 571 (2017).
- [49] R. Ivie, S. White, and R.Y. Chu, *Womens and mens career choices in astronomy and astrophysics*, Phys. Rev. Phys. Edu. Res. 12, 020109 (2016).
- [50] P. Hodkinson and A.C. Sparkes, *Careership: a sociological theory of career decision-making*, British Journal of Sociology of Education 18(1), 29 (1997).
- [51] M.W. Nielsen, *Reasons for leaving the academy: a case study on the 'opt out' phenomenon among younger female researchers*, Gender, Work and Organization 24, 134 (2016).
- [52] K. Beddoe and A. Pawley, "Different people have different priorities": work-family balance, gender, and the discourse of choice, Studies in Higher Education 39(9), 1573 (2014).
- [53] P. Bourdieu, *Distinction: a social critique of the judgment of taste* (Cambridge, Massachusetts: Harvard University Press, 1984).
- [54] P. Bourdieu, *Sociology in Question* (London: SAGE Publications, 1993).
- [55] P. Bourdieu and J.-C. Passeron, *Reproduction in Education, Society and Culture* (London: SAGE Publications, 1990).
- [56] P. Bourdieu and L.J.D. Wacquant, *An invitation to reflexive sociology* (Chicago: The University of Chicago Press, 1992).
- [57] R. Weitz, *Women and their hair: Seeking power through resistance and accommodation*, Gender and Society 15(5), 667 (2001).
- [58] G. Yair, *A different reason: How Israeli scientists think about careers and family life*, Israel Studies 25(2), 159 (2020).
- [59] S. Fogiel-Bijaoui, *Families in Israel: Between familism and postmodernism*, in D. Izraeli, A. Friedman, H. Dahan-Kalev, H. Naveh, S. Fogiel-Bijaoui, M. Hassan and H. Herzog (Eds.), *Sex, gender and politics* (Tel Aviv: Kav Adom, Hakibbutz Hameuchad, 1999) (In Hebrew).
- [60] The Israeli Central Bureau of Statistics, *Fertility rates of Jewish women and other in Israel by level of religiosity 1979-2017*, Table no. 1 <https://www.cbs.gov.il/EN/pages/default.aspx> (2020).
- [61] A. Guy and A. Shnider, *Old characteristics of gender discrimination in the new workforce structure*, The Heth Academic Center for Research of Competition and Regulation publication (in Hebrew) (2019).
- [62] Anabi, O. (2019). *Fathers' involvement in the domestic arena and ideologies of masculinity in Israeli society*. Doctoral dissertation, University of Bar-Ilan, Israel (In Hebrew).
- [63] A. Doucet, *Parental responsibilities: Dilemmas of measurement and gender equality*, Journal of Marriage and Family 77, 224 (2015).
- [64] S.S. Case and B.A. Richley, *Gendered institutional research cultures in science: the post-doc transition for women scientists*, Community Work and Family 16(3), 327 (2013).
- [65] N. Toren, *Tradition and transition: Family change in Israel*, Gender Issues 21, 60 (2003).
- [66] S. Mizrahi Simon, *Women in Israel: Central issues*, the Knesset Research and Information Center report (in He-

- brew) (2015).
- [67] R. Kark, *Women in the land of milk, honey and high technology: the Israeli case*, in R.J. Burke and M.C. Mattis (Eds.), *Women and minorities in science, technology, engineering and mathematics* (Cheltenham, UK: Edward Elgar Publishing Limited, 2007).
- [68] C. Glesne and A. Peshkin, *Becoming qualitative researchers: An introduction* (New York: Longman, 1992).
- [69] N.K. Denzin and Y.S. Lincoln (Eds.), *Collecting and interpreting qualitative materials* (Thousand Oaks, CA: Sage Publications, 1998).
- [70] R.B. Johnson, A.J. Onwuegbuzie and L.A. Turner, *Toward a definition of mixed methods research*, *Journal of Mixed Methods Research* 1(2), 112 (2007).
- [71] S. Reinharz and L. Davidman, *Feminist methods in social research* (Oxford University Press, 1992).
- [72] M.L. DeVault, *Feminism and Social Research: Liberating Method* (Temple University Press, 1999).
- [73] M. Krumer-Nevo, M. Lavie-Ajayi and D. Hacker (Eds.), *Feminist research methodologies* (Tel Aviv: Hakibutz Hameuchad Publications, Migdarim Series, 2014).
- [74] Bar Ilan University, Ben Gurion University, Hebrew University, the Technion, Tel Aviv University and Weizmann Institute.
- [75] P. Mulvey and J. Pold, *Physics doctorates: Skills used and satisfaction with employment*, AIP report (2020).
- [76] M. Eran-Jona and Y. Nir, *Ph.D. in physics as a hurdle race, and the “glass hurdles” for women*, arXiv:2007.02251 [physics.ed-ph].
- [77] R.S. Barthelemy, M. McCormick and C. Henderson, *Gender discrimination in physics and astronomy: Graduate student experiences of sexism and gender microaggressions*, *Phys. Rev. Phys. Edu. Res.* 12, 020119 (2016).
- [78] L.M. Aycock, Z. Hazari, E. Brewe, K.B.H. Clancy, T. Hoddapp and R.M. Goertzen, *Sexual harassment reported by undergraduate female physicists*, *Phys. Rev. Phys. Edu. Res.* 15, 010121 (2019).
- [79] S.J. Ceci and W.M. Williams, *The mathematics of sex: How biology and society conspire to limit talented women and girls* (New York: Oxford University Press, 2010)
- [80] U.S. Bureau of Labor Statistics, *American Time Use Survey (ATUS)*, <https://www.bls.gov/tus/>
- [81] C. Seierstad and G. Kirton, *Having it all? women in high commitment careers and work-life balance in Norway*, *Gender, Work and Organization* 22, 390 (2015).
- [82] S. Benard and S.J. Correll, *Normative discrimination and the motherhood penalty*, *Gender and Society* 24(5), 616 (2010).
- [83] M.E. Heilman and M.C. Haynes, *Subjectivity in the appraisal process: a facilitator of gender bias in work settings*, in E. Borgida. and S.T. Fiske, (Eds.), *Beyond common sense: psychological science in the court-room* (London: Blackwell Publishing, 2008).
- [84] A. Kaatz, B. Guerrez and M. Carnes, *Threats to objectivity in peer review: the case of gender*, *Trends in Pharmaceutical Sciences* 35(8), 371 (2014).
- [85] J.C. Blickenstaff, *Women and science careers: leaky pipeline or gender filter?*, *Gender and Education* 17(4), 369 (2005).
- [86] J.R. Cimpian, T.H. Kim and Z.T. McDermott, *Understanding persistent gender gaps in STEM*, *Science* 368(6497), 1317 (2020).
- [87] GENERA (Gender Equality in Physics in the European Research Area) network, <https://www.genera-network.eu/>.