

Waterloo Charter for Women in Physics

We hold as our guiding principles that:

- People of all genders are equally good in doing excellent science and deserve equal opportunity.
- Diversity contributes to excellence in science so that the full participation of people of all genders will enhance excellence in the field of physics.
- Both thought and action are necessary to ensure equal participation for all.
- The attainment of equal opportunity should be measured by outcomes. Thus, as long as the percentage of women in the next level of advancement does not equal the percentage in the pool, equal opportunity cannot be considered to exist.
- Long-term change requires periodic evaluation of progress and consequent action to address areas where improvement is necessary.

Physics has a long and honorable tradition of participation by women who have made significant and highly creative contributions to the field. However, the percentage of female physicists remains low. It is increasingly clear that scientific careers are strongly affected by social and cultural factors, and are not determined solely by merit. The search for excellence that unites all scientists can be maintained and enhanced by increasing the diversity of its practitioners. Great discoveries thrive on cross-cultural diversity. The attainment of such diversity needs revised criteria for judging excellence, free of cultural perceptions of talent and promise.

Current available data on the relative numbers and career histories of women and men in science reveals widespread discrimination: access to the profession, like graduate education, hiring, promotion, and funding, is not always independent of gender. Discrimination can be subtle or unintentional and yet creates a non-conducive atmosphere that not only discourages and distresses women but also alienates them from the field. Such discrimination can only damage the profession. Current recruitment, training, evaluation and award systems often prevent the equal participation of women. Formal and informal mechanisms that are effectively discriminatory are unlikely to change without intervention.

The IUPAP has long assumed the responsibility of implementing strategies within its own organization to improve the situation and increase the number of women physicists. The IUPAP is not only committed to introduce changes in its own structure but also to encourage the adoption of policies by institutions, scientific societies, funding agencies and other key players of the scientific endeavor that may enable women to succeed within the existing structures of physics and allow the desired acceptance of diversity to develop fully. To achieve these goals, a set of policies, action and recommendations pertaining to affirmative action, career paths and institutional policies are spelled out in the Appendix. The IUPAP strongly advises the Physical Societies of its member countries to abide by the principles of this Charter and to encourage the adoption of the recommended policies adapting them to the particularities of their own countries.

Appendices

Context

The Waterloo Charter was initiated at the fifth IUPAP International Conference for Women in Physics (ICWIP) organized by the IUPAP Working Group on Women in Physics (WIP) in Waterloo, Canada from August 5-8, 2014 and finalized during its sixth edition that took place in Birmingham, UK in July 2017. The Charter is based on the rubrics of the Baltimore Charter and the Pasadena Recommendations formulated by the American Astronomical Society in 1993 and 2003 respectively. The document is also shaped and guided by the principles dictated by the JUNO project initiated by the Institute of Physics (UK). It embraces, as well, the statements on gender equity and inclusiveness in physics that have been issued previously by the IUPAP. Presented by the IUPAP Executive Committee, this Charter was approved by the IUPAP General Assembly in 2020.

IUPAP and the rights and responsibilities of scientists

The free circulation of scientists for scientific purposes is a major piece of IUPAP policy. Its policy on this matter is consistent with the corresponding declaration of the International Science Council, and was adopted at the 26th General Assembly in 2008 and endorsed by the 27th General Assembly in 2011 states: *The principle of the Universality of Science is fundamental to scientific progress. This principle embodies freedom of movement, association, expression and communication for scientists, as well as equitable access to data, information and research materials.*

In pursuing its objectives with respect to the rights and responsibilities of scientists, the International Union of Pure and Applied Physics (IUPAP) actively upholds this principle, and, in so doing, opposes any discrimination on the basis of such factors as ethnic origin, religion, citizenship, language, political stance, gender, or age. IUPAP should only sponsor conferences and events at institutions and in countries that uphold this principle. If scientists are excluded from attending IUPAP-sponsored international conferences by a host institution or country on the basis of any of these factors, IUPAP should register its concern at the highest level of that institution or country, and should not sponsor any future events in that country until such exclusions have been eliminated.

IUPAP and women in physics

The IUPAP General Assembly held in Atlanta, Georgia, USA, in 1999 approved the creation of the Working Group on Women in Physics as Working Group 5 and charged it with the following responsibilities:

- To survey the situation for women in physics in IUPAP member countries;
- To analyze and report the data collected along with suggestions on how to improve the situation;
- To suggest ways that women can become more involved in IUPAP, including the Liaison Committees, the Commissions, the Council, and the General Assemblies.

In 2011, the position of Gender Champion was proposed to strengthen connections between the IUPAP commissions and the Working Group on Women in Physics. Since that time, every three years a Vice President at Large has been appointed to serve in that position mainly to assist in tracking the representation of women in all IUPAP

activities. Based on the collected data, a set of rules has been established to guarantee that women are represented as organizers, speakers and attendees of IUPAP sponsored and supported conferences and that conference participants receive information on inclusiveness in physics. An anti-harassment policy has also been established for such conferences.

Recommendations for inclusion and diversity in physics

1. Recommendations for Affirmative Actions in all types of selection processes

Significant advances for women have been made possible by affirmative action. Affirmative action involves the establishment of serious goals, not rigid quotas, for achieving diversity in all aspects of the profession, including hiring, invited talks, committees and awards, as well as strong efforts towards increasing diversity of the applicant pools in every level and context. To this end, we recommend that selection processes follow these rules:

- a. Women should participate in the selection process. If insufficient numbers of women are available at particular institutions, outside scientists can be invited to assist. Men must share fully the responsibility for implementing affirmative action, as they hold the majority of leadership positions.
- b. The selection of women should reflect on average their numbers in the appropriate pool of candidates and normally at least one woman should be on the short list for any position, paid or honorific. When women are underrepresented in the pool, their numbers should be increased by active and energetic recruitment.
- c. Data concerning equal opportunity for women should be widely publicized. If the goals for affirmative action are not achieved, the reasons must be determined.
- d. Women should actively be considered for prizes and awards.
- e. Women should have a very important role in scientific conferences. They should be included in their various committees and as invited speakers. The existence of a representative fraction of women among committee members and speakers should be enforced by sponsors and funding agencies for conferences to receive financial support.

2. Recommendations for Career Paths

The criteria used in hiring, assignment, promotion and awards should be broadened to include different pacing of careers, care of older and younger family members, career breaks, and demands of dual-career households. Provision for day care facilities, family leave, time off and re-entry will instantly improve women's access to a career in physics and is of equal benefit to men.

A. Academic Hiring

Traditional hiring practices may work against women as candidates for positions in research universities, laboratories, and scientific institutes, whether these are permanent, tenure-track, or contract. Statistics show that the fraction of women in the tenure-track pool has increased over the last two decades, but the fraction of women in tenured positions has not grown

commensurately¹. It is the clear responsibility of research organizations to take affirmative steps to ensure that all viable candidates for positions are actively identified and given equal opportunity both for hiring and success. While specifically calling out tenure-track and similar hiring as an area of immediate concern, we recognize that the same practices should be applied to hiring for all positions. In this spirit, we make the following recommendations to be adopted:

- a. Standards for candidates should be established and publicized in advance. Criteria that are culturally based or otherwise extraneous to performance or the pursuit of scientific excellence should not be applied.
- b. All search and selection committees for positions should contain two or more members whose specific task is to advocate for consideration of candidates from groups that are underrepresented in physics.
- c. Search and selection committees should be informed about what constitutes legal and ethical hiring practices. The IUPAP strongly encourages the relevant institutions to provide training sessions on good practices including unconscious bias training.
- d. The active recruitment of women to apply for positions should be encouraged.
- e. Diversity officers that watch for the occurrence of unconscious biases should participate in discussions on the selection and promotion opportunities.
- f. Policies that encourage flexible means of accommodating dual-career couples should be developed.
- g. Transparency and accountability in the hiring process should be required. Appropriate institutional channels should be used so that results are commensurate with the possible candidate pool.
- h. If two candidates for the same position have equal qualifications within the uncertainties, the candidate from the underrepresented group should be hired.

B. Career Advancement and Recognition

The "classic" career path for physicists in academia and institutes has been a progression through undergraduate and graduate school, a postdoc or two, and then a research faculty job at a major university. Statistics indicate that women are lost from this "progression" in proportion greater than men for a variety of reasons such as unsupportive work environments, lack of role models, and insufficient opportunity for recognition of their performance. Recognition often comes in the form of professional awards and invited presentations, where women frequently have been underrepresented relative to their achievements. Informal mentoring is easy and widespread for young people who resemble those already in the field but often is nearly inaccessible to those from underrepresented groups. We offer several recommendations to ameliorate this situation:

- a. Academic institutions should provide regular evaluation, mentoring and career counseling to young faculty members.
- b. Universities and individual departments should set up formal programs

¹ see for instance: <https://www.tiaainstitute.org/publication/taking-measure-faculty-diversity> or <https://arxiv.org/pdf/1503.01333.pdf>

to train mentors for younger students and professionals, with attention paid to both career and family issues. The individual physics and physics-related departments then should take the responsibility of implementing a mentoring program, so that their more junior members have a mechanism to acquire support and advice. Specific areas of interest for training and mentoring would include information about rules (both written and unwritten), expectations, networking, and the general decision-making process of a particular institution. The IUPAP can contribute to this effort by supporting special sessions or short training programs at the semi-annual general meetings

- c. Career development workshops with a gender perspective can be organized to provide young physicists and physics students with the tools to advance in their careers addressing gender-related problems at the same time. Based on the professional development sessions that usually take place during ICWIPs, the International Centre for Theoretical Physics of Trieste has run these workshops yearly since 2013². Similar workshops have been organized in different countries of Latin America yearly or once every two years since 2014, the latest one of which took place in 2017 in Bogota, Colombia³. Physical societies could include training sessions of this sort during their meetings and PhD programs could include them as part of their curricula.
- d. Ph.D.-granting universities should recognize the potential of graduate-student applicants from institutions that traditionally serve underrepresented groups. Departments should develop working relationships with faculty at these institutions, and establish specific mentoring programs for graduate students who may undergo "culture shock" upon arrival at a major research university.
- e. Decisions on advancement should result from an open process, based on specific criteria that are spelled out in advance. Senior faculty and other senior personnel must provide an environment that enables all junior faculty to have an equal opportunity to succeed and advance in this process.
- f. Along with direct contributions to science, criteria for success should include teaching and other functional terms of employment. Specifically, outreach and education activities are important both for the future of physics and in relation to possible career paths; involvement in such activities should be supported and rewarded at all levels, including hiring decisions and performance evaluations. Paradoxically, individual women sometimes are heavily burdened with committee service in an effort to achieve greater diversity; this additional service also should be recognized in advancement decisions. These tasks should be allocated fairly taking "career level" into consideration, e.g., mid-career women should not be forced to mentor younger students at the expense of themselves being mentored.
- g. The responsibility to create institutional changes that promote equity in physics lies first and foremost with the senior and more established members of an institution. However, individuals at a more junior level have a strong interest in such change and should participate as is feasible. In addition, these younger physicists should not be thwarted by apparent barriers, but should enthusiastically pursue their own

² see e.g., <http://indico.ictp.it/event/7995/>

³ see https://emcyt_icsu017.uniandes.edu.co/

- goals and dreams for scientific achievement and career advancement.
- h. There should be sufficient support and flexibility to allow a woman to work part time and be accord the same benefits and privileges as a full time staff.

C. Varied Career Paths

Many, if not most, professional physicists worldwide are employed in positions other than academic positions at universities. Examples are employment at national or private laboratories, colleges that do not grant PhDs, science centers, industry, various roles in science or university management, and in government. The paths to these roles typically are not well understood, nor are the opportunities available to develop skills that are useful in these various types of positions. We offer several recommendations to ameliorate this situation:

- a. Academic departments should encourage outside training in non-research fields, such as program/project management or science policy, in order to prepare their students for the possibility of future careers in managing a variety of scientific endeavors. This may include, for example, courses outside the academic department or department seminars given by people in various related careers.
- b. Educational institutions that are co-located with related industrial employers, research institutions, or observatories should establish specific programs that enable students to "cross-train" between the university and the other organizations. Likewise, informal and formal science discussions, mentoring groups, seminars and colloquia at these professional institutions should have an open door policy and encourage student participation.
- c. Mentoring programs such as that recommended in the section on "Career Advancement and Recognition" should include discussions and explorations of options outside the traditional faculty progression; physics departments should work with their university's career development centers, and with their own graduates, to provide information about these options to their undergraduate and graduate students.

D. Scientific Conferences, Awards and Popularization of Science

The contributions of women physicists very often go unnoticed. This has a direct impact on their career advancement since most schemes look at the previous impact of the candidates to decide on their promotion and hiring. This also affects society perception since most often it is men's achievements that are highlighted in the press perpetuating gendered stereotypes. A stereotype is any thought widely adopted about specific types of individuals or certain ways of behaving intended to represent the entire group of those individuals or behaviors as a whole⁴. We are willing to change existing

⁴ McGarty, Craig; Yzerbyt, Vincent Y.; Spears, Russel *Stereotypes as explanations: The formation of meaningful beliefs about social groups*. (Cambridge: Cambridge University Press, 2002).

stereotypes on gender and science that are quite pervasive and hard to shift. We offer several recommendations to ameliorate this situation:

- a. Organizations and academic institutions should offer women equal opportunity for scientific recognition in the form of awards (IUPAP awards and others) and invitations to present invited talks in a variety of circumstances, including all IUPAP and physical societies meetings, topical professional meetings, and traditional colloquia/seminars.
- b. Prize nominee pools and invited speaker lists should adequately reflect the diversity of the physics profession.
- c. The institutions responsible for selecting awardees and invitees should review periodically their policies and progress in order to ensure that the achievements of women are being represented fairly. It is recommended that regular reports on the situation be provided within the institutions and at the conferences or other activities that they organize.
- d. Open nominations, self-nomination for awards, memberships or fellowships should be allowed.
- e. All participants of conferences and related activities should enjoy an environment which encourages the free expression and exchange of scientific ideas, and is free from all forms of discrimination, harassment, and retaliation. It is advisable that conference sponsors require that, as done by the IUPAP, conference organizers name an advisor who will consult with those who have suffered from harassment and who will suggest ways of redressing their problems, and an advisor who will counsel those accused of harassment. After due consideration the conference organizers should be able to take such action they deem appropriate, including warning or expulsion from the conference without refund.
- f. Conferences and other related activities provide the opportunity to highlight the relevance of diversity and inclusiveness in physics and to discuss possible measures to advance in this regard. As required by the IUPAP for its sponsored conferences, special sessions on inclusiveness could be organized. Another possibility is to have exhibits portraying the contributions of women physicists or of members of other under-represented groups.
- g. Most institutions and scientific journals have press services through which they highlight pieces of research describing them for a general public. News services usually take up these releases to generate their own scientific news. The public perception of science is strongly shaped by this type of publications that have a direct impact on the creation and persistence of stereotypes. Institutions should take special care to portray the achievements of women physicists using all types of media to help change these stereotypes.
- h. Women should be selected often as spokespersons of collaborative groups to convey information on research results. They should also be invited to interviews of all sorts to talk about their research.
- i. Institutions and physical societies should be involved in the development and realization of actions aimed at changing gender stereotypes in science by celebrating the contributions of women physicists. The International Day of Women in Girls in Science that is observed every year on February 11th, as decided by the United Nations, provides a good opportunity to highlight and celebrate the contribution of women scientists. The IUPAP has adopted February 11th as the International Women in Physics Day as well. We

recommend that all physics related institutions organize activities on that day to help change gendered stereotypes in physics.

3. Recommendations for Institutional Policies

A. Professional misconduct

Strong action must be taken to end sexual harassment. Education and awareness programs are standard in many governments and in the industry and should be adopted by the physics community. Each institution should implement an enforceable policy to receive complaints about sexual harassment and to participate in the formal review process. Action against those who perpetrate sexual harassment should be swift and substantial.

B. Cultural Issues

Some of the strongest, but most difficult to quantify, reasons that individuals from underrepresented groups can feel disadvantaged arise from a mismatch with the majority "culture" --i.e., implicit norms and expectations of behavior. Specific recommendations that are made above would go far toward dealing with some of these issues in terms of policies and practices, but there remains a large gray area of subtle cultural issues that contribute to the underrepresentation of women in tenured and other leadership roles. In the words of Jocelyn Bell Burnell (Science 304, p. 489, 2004): "Women and minorities should not do all the adapting. It is time for society to move toward women, not women toward society." We offer several recommendations to ameliorate this situation:

- a. Institutions should encourage diversity training and make it available at all levels. This should include discussions of the well-studied effects of subtle discrimination, unconscious bias, and the accumulation of disadvantage.
- b. In an era in which the ability to work within a large team is becoming increasingly important for scientific success, departments should foster a collaborative and team-oriented approach rather than just the more traditional, competitive scientific culture. Responsibilities and rewards should be shared equitably in the team environment. It is also expected that such a team should be composed of diverse members of the department, where appropriate (for example, men and women, junior and senior faculty, students, etc.).
- c. Good communication channels should be maintained and encouraged throughout academic departments and laboratories, both within peer groups and spanning traditional hierarchical levels. Department chairs should organize regular opportunities for two-way communication throughout the hierarchy.
- d. Institutions should ensure that a career in research is compatible with having a family; professional activities (e.g., class and meeting schedules) as well as employment benefits (e.g., childcare, family leave, etc.) should be developed with this specific goal in mind.

C. Statistical Information

Evidence of the underrepresentation of women in the physics community relies on insufficient long-term statistical data. Better longitudinal data, specific to physics, are needed to assess both women's representation and the effectiveness of remedies. The issue of statistics must be recognized for its central importance to understanding the social and cultural forces that shape the characteristics of our field. Working Group 5 has been involved in a Global Survey to collect data on the conditions for women in physics across the world. The baseline Global Survey of Physicists (2009-2010) was remarkable for having 14932 respondents from over 130 countries in 8 languages. The data is currently being updated through a Global Survey of Scientists that has opened for responses on May 1st, 2018. The survey is part of a collaborative project to study the Gender Gap in Science that is lead by the International Mathematical Union and the International Union of Pure and Applied Chemistry and involves the participation of 11 partners, among them, the IUPAP (<https://gender-gap-in-science.org/>). In order to have updated information with some regularity we recommend the following:

- a. Physical societies and physics departments should continuously be involved in surveying the situation of physicists both locally and internationally. We recommend that they adopt the questions in the Global Survey of Physicists and of Scientists for their own use within their countries. We also recommend that questions pertaining to cultural perception and bias be crafted into the survey.
- b. Physical societies should advocate that the data that are collected by the various scientific institutions be gender-segregated. They should also advocate for the development of good gender indicators that would be useful to obtain such segregated data.

D. Safety and environment

Recommendations:

- a. Gender-neutral language and illustrations are important in the formation of expectations, both by those in power and those seeking entrance to the profession. Documents and discussions should be sensitive to bias that favors any one gender, race, sexual orientation, life style, or work style. Those who represent physics to the public should be particularly aware of the power of language and images that, intentionally or unintentionally, reflect on Physics as a profession.
- b. Physical safety is of concern to all physicists and of particular significance to women, who often feel more vulnerable. This issue must be addressed by those in a position to affect security, making it possible for everyone to work in a safe environment.

4. Recommendations to reverse stereotypes and attract a diverse pool of people to physics

We have already addressed the issue of gender stereotypes in science in other parts of this Appendix. Stereotypes affect human actions enormously since they shape the fast brain processing with which many decisions are made. Here we want to focus on how stereotypes affect our self-judgment and career choices and on the actions that can be taken to change stereotypes and, in this way, attract a more diverse group of people to physics. The common idea that science and femininity are incompatible has

affected the self-perception of girls and women and influenced the career choices of all genders. As stated by Londa Schiebinger of Stanford University, *stereotype threat* can make people conform to negative stereotypes of their social group and undermine their performance. This researcher also provides evidence that the self-selection into certain career pathways is, in part, driven by a gendered sense of what one is good at, not simply aptitude or interest. Stereotypical objects in science workspaces, on the other hand, discourage interest among groups that do not fit the stereotype. But even once a career in science is chosen, many more women than men are affected by the *impostor syndrome*, a psychological pattern by which a person doubts his/her accomplishments and fears to be exposed as a "fraud". Even though public perception has changed over the years, something that is reflected in that 34% of US kids now draw a woman when asked to portray a scientist as opposed to less than 1% in the 1960s and 1970s⁵, much more needs to be done. The scientific community should get engaged in actions to change gender stereotypes and these common perceptions. Some of the ways in which this can be done are:

- a. Having outreach activities for school kids organized as parts of physics conferences is a good way to the scientific community with girls, boys and adolescents that can be used to reverse gender stereotypes. In particular the IUPAP Working Group on Women in Physics recommended the IUPAP that such outreach activities be organized within IUPAP sponsored conferences. All ICWIPs do include these activities.
- b. Getting involved in the elaboration of material to be presented in print or over the Internet is a good option. The Gender Gap in Science Project plans to generate materials for parents and teachers that is going to be made available at its website (<https://gender-gap-in-science.org/>).
- c. To ameliorate the impostor syndrome and help young scientists transverse their early career years, setting up a mentoring or counseling scheme outside the scientists institutions can be helpful. Scientific conferences provide an opportunity where the mentor/mentoree scheme can be initiated.

Final words and useful links

The IUPAP shares with the scientific community at large the view that diversity and inclusiveness are key for the advancement of science and that specific measures need to be taken to guarantee their occurrence. The list of recommendations included in this Appendix is far from comprehensive. Many organizations are producing useful material that is made available on the Internet. We recommend that those interested in developing and applying specific policies for a more diverse and inclusive practice of science visit those sites. In particular, the site of the Gender Gap in Science Project (<https://gender-gap-in-science.org/>) in which the IUPAP participates will make available statistics on the gender gap, a database of good practices and useful material to be shared with the scientific community and the general public. The Latin American chapter of the project also has its own website with useful information, mostly about Latin American initiatives (<http://wp.df.uba.ar/ggapsla/>). The UNESCO STEM and Gender Advancement (SAGA) Project will also provide information in this regard including examples of

⁵ K. Langin "What does a scientist look like? Children are drawing women more than ever before", Science Magazine, Mar. 20, 2018.

good indicators to generate gendered-segregated data (<https://en.unesco.org/saga>).
Other interesting sites are:

- Hypatia Project (EU Horizon 2020): <http://www.expecteverything.eu/hypatia/>
- Advance Project (US National Science Foundation):
https://www.nsf.gov/funding/pgm_summ.jsp?pims_id=5383
- StratEGIC Toolkit: www.strategictoolkit.org
- Project Juno (UK IoP):
<http://www.iop.org/policy/diversity/initiatives/juno/index.html>
- Athena Swan Charter: <https://www.ecu.ac.uk/equality-charters/athena-swan/>
- Gendered Innovations: <http://genderedinnovations.stanford.edu/>