

The Persistent Gender Gap in Physics: Unpacking Barriers and Charting a Path Towards Sustainable Equity

Dr. Sujatha R

Associate Professor in Physics Government First Grade College, HSR Layout, Bengaluru- 560102

DOI: <https://dx.doi.org/10.51584/IJRIAS.2026.11010074>

Received: 21 January 2026; Accepted: 28 January 2026; Published: 07 February 2026

ABSTRACT

The advancement of women in physics continues to lag significantly behind that in the life sciences, despite concerted efforts by the physics community. This report examines the complex factors contributing to this persistent disparity, analyzing why progress remains slow and why gains from initiatives often revert to previous levels. While traditional arguments such as teaching and research loads or work-life balance are comparable across these disciplines, the analysis reveals that perceived gender bias, the pervasive belief in innate talent coupled with the stereotype that women lack it, and unsupportive academic cultures are dominant differentiating factors. The report synthesizes current statistical landscapes, delves into the root causes of underrepresentation and slow advancement, and explores the limitations of past interventions. Drawing on findings from global projects and promising local practices, it proposes a comprehensive set of actionable recommendations. These recommendations emphasize the necessity of systemic and cultural transformation across the entire academic pipeline, from early education to senior leadership, to foster truly inclusive environments and ensure sustainable gender equity in physics. Achieving this is not merely a matter of social justice but a critical imperative for scientific excellence and the global capacity to address pressing societal challenges.

Key words : gender gap, gender equality, sustainable development, women in physics, leaky pipeline

INTRODUCTION: THE ENDURING DISPARITY IN PHYSICS

The Imperative of Gender Equality in Science for Sustainable Development

Science and innovation are foundational pillars for addressing the complex economic, social, and environmental challenges facing the world today. Achieving sustainable development pathways critically depends on the equal participation of both men and women in scientific endeavors [User Query]. When the talent pool is limited by creating barriers for girls and women to pursue scientific careers, the collective capacity to solve complex problems, including urgent issues like climate change, is inherently compromised.[1]

Research consistently demonstrates that diverse scientific teams are more likely to outperform homogenous teams, even when the latter are composed of individuals with seemingly greater individual abilities.[2] This enhanced performance stems from the varied experiences and perspectives that diverse backgrounds bring, leading to different approaches to problems, more innovative solutions, and ultimately, more novel and impactful research.[2, 3] Therefore, the underrepresentation of women in physics is not merely a social justice concern; it represents a tangible impediment to scientific progress and the global ability to develop robust solutions for pressing societal issues. The full utilization of scientific talent, irrespective of gender, is essential

for unlocking creativity, fostering discovery, and ensuring that scientific advancements truly serve the needs of a non-homogeneous global population.[1, 3]

The Persistent Underrepresentation of Women in Physics

Despite the significant contributions of notable women scientists throughout history in various fields of physics, the current proportion of female scientists in this discipline remains remarkably low when compared to their male counterparts [User Query]. The physics community of practice has indeed been active at many levels in promoting the advancement of women. However, the percentages of women in university departments generally

remain lower in physics than in the life sciences, and a concerning pattern observed is that comparative numbers tend to revert to their former levels after the conclusion of initiatives designed to improve gender balance [User Query].

This report aims to delve into the underlying reasons for the relatively slow advancement of women in physics and to understand why the gains from well-intentioned initiatives often prove unsustainable. By analyzing available research, this paper seeks to illuminate the factors contributing to fewer women pursuing physics as a career and to propose actionable strategies for enhancing women's involvement in modern science, particularly within the field of physics.

Current Landscape: Women's Representation In Physics Vs. Life Sciences

The journey of women through the academic pipeline in physics reveals a stark contrast with their representation in the life sciences, illustrating a significant and persistent disparity at every stage.

Comparative Statistics Across the Academic Pipeline

High School: At the foundational level, there is considerable engagement from young women in physics. In 2013, 46% of high school physics students were young women, a percentage that had remained stable since 2003. Furthermore, by 1997, nearly half of all high school physics students were girls.[4, 5] However, a critical divergence appears in performance metrics: only 30% of young women passed the Physics 1 exam with a score of 3 or higher, compared to 48% of young men.[4] This suggests an early challenge in translating interest and exposure into measured competence or confidence.

Bachelor's Degrees: The underrepresentation becomes pronounced at the undergraduate level. Women earn just 21% of bachelor's degrees in physics.[4, 6, 7, 8] This figure has shown little change, remaining stable between 2007 and 2017 [4] and even from 1998, when it stood at 19%.[5] This contrasts sharply with the broader academic landscape, where women earn over 50% of all bachelor's degrees.[4, 5, 7] In biological sciences, women's representation is significantly higher, earning over 60% of bachelor's degrees in 2018 [9] and approximately 60% in 2017.[7]

Doctoral Degrees: The trend of underrepresentation continues into graduate studies. Women earned 17% of physics PhDs in 2010 [6], increasing slightly to 20% in 2017 [4] and 2018.[7, 8] This marks a modest rise from 18% in 2007.[4, 7] In stark contrast, women earned over half of doctoral degrees in biological sciences in 2018.[9] Even within physical sciences, astronomy demonstrates better gender balance, with women earning 40% of doctorates in 2017.[4]

Faculty Positions: The disparity persists in academic careers. In 2014, women constituted only 16% of physics faculty members, though this was an increase from 10% in 2002.[4] By 2022, 18% of physics faculty positions at US universities were held by women.[10] This figure is considerably lower than in other scientific disciplines; for instance, women make up nearly half of the faculty in some university biology departments, and 70% in behavioral and social sciences.[11] While one study suggested that the absence of women in some physics departments is a statistical outcome of the low overall number of women in the field and small department sizes, rather than direct hiring bias in every instance, it explicitly states that this does not negate the existence of discrimination or hostile environments within the discipline.[12] **Leadership/Senior Roles:** The underrepresentation of women becomes even more pronounced at senior and leadership levels. In the life sciences, despite women filling half of entry-level positions, they constitute only 10% of boards and 20% of leadership teams.[13] In physics, women occupied only 10% of full professor positions in 2014. While this is partly attributed to fewer women earning doctorates in the past, implying that current numbers are somewhat consistent with the historical pipeline [4, 14], the current lack of senior female role models remains a significant concern. A recent study highlighted that fewer than one in 10 senior authors in a prestigious physics journal are women, with Canadian-led papers showing zero female senior authors over a decade, indicating a clear bias in the training and recognition of young scientists.[10]

The "Leaky Pipeline" Phenomenon

The data presented above vividly illustrates the "leaky pipeline" phenomenon in physics: the participation of women consistently decreases with each progressive step up the academic ladder.[5] While nearly half of high school physics students are girls, less than one-fifth of bachelor's degrees in physics are earned by women five years later.[5] This trend of diminishing representation continues through graduate school and into faculty positions.[8]

The "leaky pipeline" in physics is particularly severe and persistent, indicating that the field struggles not only with attracting women but significantly with retaining them, especially at critical transition points from high school to undergraduate studies and from graduate studies to faculty positions. The sharp drop-off in representation from high school to bachelor's degrees, and the continued decline through advanced degrees and faculty ranks, suggests that fundamental issues within the discipline are pushing women out.

Furthermore, the disparity is not just about absolute numbers but also about the rate of progress and comparative representation across fields. Compared to other STEM disciplines, women are "sorely underrepresented" in physics at both bachelor's and PhD levels.[5] For example, while engineering historically lagged behind physics in female representation, it now has approximately the same percentage of female graduates.[5] The percentages of women earning bachelor's degrees in life sciences and chemistry have increased at a much more rapid rate than in physics.[5] Physics' unique stagnation in female representation, even as other STEM fields catch up or surpass it, points to deeply embedded, field-specific cultural and structural issues that are more resistant to change. This comparative slowness, despite general increases in women in higher education, suggests that physics faces distinct, more formidable challenges than other disciplines, making the advancement of women relatively slow and the gains from initiatives difficult to sustain.

Table 1: Percentage of Women at Key Career Stages in Physics vs. Life Sciences (U.S. Data)

Career Stage	Physics (%)	Life Sciences (%)	All Bachelor's Degrees (%)
High School Students	46-47% [4, 5, 6]	N/A	N/A
Bachelor's Degrees	21% [4, 6, 7, 8]	60-65% [7, 9]	>50% [4, 5, 7]
Master's Degrees	20% [5, 9]	>50% [9]	44.7% [9]
Doctoral Degrees	17-20% [4, 6, 7, 8]	>50% [9]	41.2% [9]
University Faculty	16-18% [4, 10]	~50% [11]	N/A
Full Professor Positions	10% [4]	N/A	N/A

Note: Data points reflect various years between 2009-2022, as available in the provided sources. "N/A" indicates data not explicitly provided in the research material for direct comparison.

Root Causes Of Slow Advancement In Physics

The persistent underrepresentation and slow advancement of women in physics stem from a complex interplay of factors, extending beyond simple work-life balance considerations. These include pervasive gender bias, the detrimental "innate talent" stereotype, and unsupportive academic and workplace cultures.

The Pervasive Influence of Perceived Gender Bias and Discrimination

Empirical evidence consistently documents a gender bias against women and their research, favoring men, across science, technology, engineering, and mathematics (STEM) fields.[15] This bias manifests in various forms, from overt discrimination to more subtle, often unconscious, evaluations. Studies have shown, for instance, that

science professors, regardless of their own gender, evaluate identical applications more favorably if the applicant has a man's name compared to a woman's name.[15] This suggests that deeply ingrained biases can influence critical career progression points, such as hiring and promotion decisions.

A concerning aspect of this bias is the differential receptivity to its existence. Men, particularly male faculty within STEM, tend to evaluate research demonstrating gender bias less favorably than women.[15] This relative reluctance to accept evidence of gender biases can perpetuate a cycle of disadvantage, as those in positions of power may not fully recognize or acknowledge the pervasive nature of the problem, making it harder to address effectively. Furthermore, sex-based differences in access to resources and opportunities have been observed to hold regardless of age or employment sector, indicating a systemic issue that transcends specific career stages.[6]

Women in physics report significantly more negative experiences with their advisors and other students compared to men. They are also significantly more likely to report experiencing discrimination or sexual harassment at work or school.[4, 16] A global survey of physicists revealed that about half of women (53%) felt discriminated against in the assessment or evaluation of their achievements because of their gender, and 29% reported personally experiencing sexual harassment at school or work.[7] Women in STEM jobs are much more likely than men to state that they have experienced discrimination at work because of their

gender and consider it a major reason for the underrepresentation of women in these fields.[17] While it is true that over one-third of physics departments may have no women among their faculty, studies suggest that this is largely a statistical outcome of the low overall number of women in physics and the prevalence of small departments, rather than direct evidence of hiring bias in every instance. In fact, more departments than statistically expected have at least one female faculty member.[12] However, this statistical observation does not negate the existence of discrimination, hostile environments, or the ongoing need to address gender representation in American universities.[12] The existence of a "male-coded" image of physics [18] and the stereotype of physicists as socially inept individuals with poor interpersonal skills [19] contribute to an unwelcoming environment. This cultural coding can lead women to feel that they must either abandon aspects of their identity to conform to these norms or leave the field altogether, amplifying the impact of explicit and implicit biases and contributing to the perception that women "do not fit" in physics, irrespective of their actual competence.

The "Innate Talent" Stereotype and its Detrimental Impact

A significant factor contributing to the gender gap in physics is the pervasive belief that success in the field hinges on "innate ability" or "unteachable brilliance." Disciplines where academics strongly associate success with such inherent talent tend to exhibit larger gender gaps.[7, 20, 21] Physics, for instance, scored an average of 4.41 out of 7 on a scale measuring the perceived importance of natural ability, which correlates with its low proportion of female PhDs (18% in physics compared to 49.5% in neuroscience).[20]

This emphasis on "brilliance" over hard work creates a self-reinforcing cycle. The underrepresentation of women is hypothesized to stem from the stereotype that women possess less natural ability in subjects like physics and are more likely to succeed through sheer effort.[20] This stereotype has a profound impact on confidence and motivation. Data indicates a troubling trend where girls' self-perceived abilities in math and science have plummeted from 73% in 2017 to 59% in 2023, even among those with strong academic performance.[22] This "crisis of confidence" is directly linked to girls internalizing messages that they are not inherently good enough or smart enough for certain careers, including physics.[22] The phenomenon of stereotype threat further compounds this issue. Stereotype threat occurs when the concern about confirming a negative stereotype about one's group interferes with performance.[23] Studies in physics have demonstrated that when stereotype threat is activated—for example, by explicit negative statements about gender differences or implicit cues—female students perform significantly worse on physics problems and conceptual assessments compared to male students.[23, 24] Crucially, this performance gap disappears in "nullified" conditions where the test is presented as gender-neutral or where the stereotype is explicitly disarmed.[23, 24] This demonstrates that the belief in innate talent, and the accompanying stereotype that women lack it, actively creates performance differences and deters participation, rather than merely reflecting pre-existing differences in ability.

The emphasis on "genius" over hard work in physics not only discourages women but also fosters a fixed mindset culture that can hinder learning and persistence for all students, particularly those who encounter challenges.

Professors who believe that "basic intelligence can't change" are more likely to advise struggling undergraduates to drop their classes.[25] For women, who are already battling societal stereotypes about their innate ability in physics, such an environment can be particularly discouraging. They may internalize struggles as a confirmation of their supposed lack of talent rather than an opportunity for growth and development, further contributing to the "leaky pipeline" by pushing them out of the field.

Unsupportive Academic and Workplace Cultures

Beyond explicit biases and stereotypes, the academic and workplace cultures within physics can be profoundly unsupportive for women, contributing to their underrepresentation and slow advancement. Women consistently report a less positive social experience in undergraduate physics programs [26]. They are more likely to feel discouraged by interactions with both students and faculty members, rate their department climate as more negative, and feel less comfortable interacting with professors outside of class. [26] Hostile experiences, including isolation, subtle micro aggressions, and overt discrimination or harassment, are common occurrences. [27, 28, 29, 30]

The prevailing image of a scientist has long been that of a middle-aged white man who works alone.[19] Physicists are often perceived as single-minded individuals with poor interpersonal skills.[19] This perception aligns with a competitive structure often found in physics classes, where students may need to compete for recognition and attention.[19] Such competitive environments can be detrimental to girls, who have been found to perform worse or shy away from competitive situations in mixed-gender settings.[19] In contrast, women often express a preference for collaborative learning and environments.[31, 32] The cultural misalignment between physics' perceived "thing-oriented" and individualistic nature and women's higher communal goals, such as working with or helping other people, creates a significant "push" factor.[1, 11, 33] This makes physics less appealing even if women are academically capable, as they may not perceive a path to integrate their values within the discipline.

Gendered dynamics are also observed in laboratory settings. While overall participation levels in various lab activities may not differ significantly across genders, non-male students tend to express greater preferences and comfort levels for tasks such as note-taking, calculations, and graphing, whereas male students gravitate more towards hands-on equipment handling.[28] Without active intervention to structure equitable group dynamics, gendered divisions of roles can emerge, potentially leading to inequitable learning experiences.[28, 34] Furthermore, boys have been observed to dominate teacher-student interactions and control experiments in labs, further marginalizing girls.[19]

A significant contributing factor to women's underrepresentation is the scarcity of highly visible female scientists in the past, which has resulted in a persistent lack of role models for aspiring women in STEM.[35, 36, 30] The presence of role models is considered crucial for inspiring young girls to pursue careers in science.[37, 38] This absence of visible female physicists who embody both scientific success and communal impact means that women may not see a viable path to reconcile their values with a physics career, leading them to fields like biology that are perceived as more aligned with helping others.

The academic culture in physics is not merely unsupportive but can be actively "hostile" for women.[8] This hostility is deeply ingrained in the discipline's culture, requiring women to "abandon expressing some of their identities to fit in the norms of the physics community or leave altogether".[19] This environment, perpetuated by norms that prioritize individualism and competition and by gendered interaction patterns that marginalize women, makes it challenging for women to feel a sense of belonging and to persist in the field.

Re-evaluating Work-Life Balance as a Contributing Factor

The user query notes that arguments relating to teaching and research loads and work-life balance are comparable in physics and life sciences. Indeed, both men and women in STEM fields generally express negative views regarding work-life balance in research-based careers compared to other professions requiring graduate degrees.[39, 40] However, while the *demands* of academic careers might be objectively comparable, the *cultural expectations* and *structural flexibility* within physics may amplify the negative impact of work-life challenges disproportionately on women, making it a more significant deterrent for them in physics than in life sciences.

Women are consistently more likely to report making career compromises for family reasons.[4, 6, 11, 21, 36, 41] The "unusually individualized and competitive nature of academic research" can make achieving work-life balance particularly difficult.[42] In such environments, men tend to be more comfortable with forgoing family time for work.[42] Research indicates that women in their mid-30s, a critical career stage, often place less value on their careers and more on family, friendships, and community.[33] This preference for a more integrated personal and professional life, coupled with the perceived inflexibility or intense demands of physics, can lead women to opt out.

Furthermore, the perception of physics as less "communal" or "people-oriented" [11, 18] might indirectly contribute to work-life balance issues for women. Fields that are perceived to align more closely with women's values, such as the life sciences with their direct applications to health and societal well-being, might implicitly offer more flexibility or a better "fit" for integrating personal and professional lives. This subtle connection means that work-life balance is not just a direct challenge but is intertwined with deeper cultural preferences and perceptions of the field's purpose, which can influence women's choices to leave physics for disciplines perceived as more compatible with their broader life goals.

Other Contributing Factors

Several other factors contribute to the underrepresentation of women in physics, often acting cumulatively to steer them away from the discipline.

Perceived Lack of Social Relevance: Women are more likely to express a desire to engage in work that directly helps others. They often link biology to tangible outcomes like "curing cancer," whereas physics is frequently associated with "hard, abstract math".[18, 43] This perception can make physics seem less appealing to women who prioritize communal goals in their career choices.[11, 33] Actively stressing the social benefits and realworld applications of physics research, such as its role in cancer treatment, clean energy development, or climate change solutions, could significantly attract more women to the field.[18, 14, 30]

Early Socialization and Declining Interest: The process of disengagement often begins early. Girls may internalize messages that they are inherently bad at mathematics and science from a very young age.[1, 18,

30] This early socialization contributes to a decline in their interest in STEM fields. By middle school, girls begin taking fewer STEM classes and increasingly believe they are worse at science and math, leading to a widening achievement gap.[44, 21, 30] Their interest in STEM generally continues to decline throughout high school, unlike for boys.[21] The cumulative effect of early socialization, perceived lack of social relevance, and misaligned pedagogical approaches creates a powerful "push" factor for women out of physics, even before they encounter explicit workplace biases.

Pedagogical Approaches: Traditional teaching styles in physics may also contribute to the gender gap. While men often appreciate a more analytical approach, which is common in many STEM classes, women tend to prefer more hands-on techniques.[11] Furthermore, early physics courses are often lecture-based and focus on surface-level learning, which may leave girls

behind, as they often desire a deeper understanding of subjects from a young age.[8] This mismatch in teaching styles can lead to disengagement and a diminished sense of belonging for female students.

Racial and Ethnic Underrepresentation: The challenges are further compounded for women from underrepresented racial and ethnic groups. African-American and Hispanic women remain significantly underrepresented in physics and astronomy.[4] Women of color face additional barriers, navigating the "double bind" of both racism and sexism within STEM pathways, often encountering limited diverse faculty and a lack of specific support systems.[45]

The Challenge Of Sustaining Progress: Why Numbers Revert

A critical challenge in addressing the gender gap in physics is the observed tendency for numbers to revert to former levels even after initiatives are implemented. This suggests that many interventions, while well-intentioned, may not be addressing the fundamental, systemic issues that perpetuate the disparity.

The "Hostile Obstacle Course" Metaphor

The concept of a "hostile obstacle course" provides a powerful metaphor for understanding the systemic nature of barriers faced by women in academic STEM.[27] This metaphor suggests that the environment itself is inherently imbalanced, favoring those already in positions of privilege (predominantly men in physics) due to deeply embedded structural barriers. This means that the challenges women face are not isolated incidents or individual shortcomings but rather a continuous series of obstacles woven into the fabric of the academic culture.

The "hostile obstacle course" signifies that barriers in physics are not isolated incidents or individual shortcomings but systemic, structural challenges deeply embedded in the academic culture, making sustained progress difficult without fundamental institutional reform. This framework highlights that institutions bear the primary responsibility for removing these barriers, rather than placing the burden on individuals to navigate or overcome them.[27] Consequently, diversity and inclusion work often disproportionately demands time and effort from members of underrepresented groups, who are already navigating these obstacles, further exacerbating their challenges.[27] As long as the underlying "obstacle course" remains intact, any progress achieved through individual efforts or short-term initiatives is likely to be temporary, leading to the observed reversion of numbers.

Limitations of Individual-Focused Interventions vs. Systemic Change

Past efforts to increase women's participation in STEM have often focused on individual-level interventions, such as encouraging girls to pursue science or providing support networks.

However, research indicates that simply informing women and girls about STEM opportunities is unlikely to make a significant difference to the gender gap unless accompanied by other comprehensive supporting strategies.[46, 47] This suggests a fundamental mismatch between the scope of many interventions and the nature of the problem.

The lack of retention of women in physics is a major issue, indicating that "something about the field of physics is incentivizing these women to leave".[8] To genuinely address this, organizational change is required to enable minoritized groups, including women, to remain in the field.[8] This implies a need to change the very "course of the pipeline" rather than merely attempting to fix "leaks" by supporting individuals within a flawed system.[8] While initiatives like Women in Physics groups on campus and Conferences for Undergraduate Women in Physics (CUWiP) provide crucial social support, mentorship, and a sense of community for women [26, 44, 48], these individual-level supports are often insufficient to overcome deeply ingrained systemic issues.[8, 14]

The reversion of numbers after initiatives reflects a fundamental mismatch between the scope of interventions (often individual-focused support) and the nature of the problem (deeply ingrained systemic and cultural barriers). Without addressing the "hostile obstacle course" directly through comprehensive organizational change, efforts merely create a "revolving door" where women are attracted to physics but are not sustainably retained. They enter the field, encounter the systemic barriers, and eventually leave, leading to a cyclical pattern of limited progress and subsequent regression. This highlights the necessity for interventions that target the structural and cultural foundations of the discipline.

Lack of Sustained Institutional Commitment, Monitoring, and Evaluation

For institutional commitment to diversity to be sincere and effective, it is vital that resources and incentives for holistic evaluations of diversity interventions are reliably available and that their findings are disseminated.[27] This approach aims to discourage superficial "box-ticking exercises" that might appear to address diversity without leading to genuine, lasting change.[27] Projects focused on advancing gender equality in scientific organizations aim to foster systemic change by supporting the implementation of practical monitoring and evaluation systems. These systems are designed to track progress, identify gaps, and continuously strengthen gender equality initiatives across member organizations.[37] The "Gender Gap in Science" project, for instance, specifically called for the establishment of a coalition on gender equality to coordinate transformative action, emphasizing the need for sustained, collective effort.[37]

The lack of sustained, rigorous monitoring and evaluation, coupled with a tendency towards superficial "boxticking" exercises, prevents organizations from accurately identifying effective strategies and making the long-term, data-driven commitments necessary for sustainable change. Without continuous data collection, analysis, and a commitment to adapting strategies based on evidence, initiatives are prone to losing momentum and failing to address the evolving nature of the barriers. This results in a lack of sustained progress and contributes to the observed reversion of numbers after initial interventions.

GLOBAL INITIATIVES AND PROMISING PRACTICES

Recognizing the persistent challenges, several global and local initiatives have emerged to promote women in physics and science more broadly, offering valuable models for future action.

International Union of Pure and Applied Physics (IUPAP) Working Group on Women in Physics (WG5)

The International Union of Pure and Applied Physics (IUPAP) established its Working Group on Women in Physics (WG5) in 1999. Its mandate is to survey the current situation of women in physics, report findings, and suggest means to improve their representation and advancement.[49, 36, 50]

A core activity of WG5 is organizing the International Conference on Women in Physics (ICWIP) every three years. These conferences bring together men and women from over 92 countries to share national reports on the status of women in physics, exchange good practices, propose and implement improvements, and foster networking.[50] This global platform is crucial for collective learning and coordinated action. WG5 has also conducted global surveys of physicists, including men since 2009-10, with the latest survey in 2018 being part of the broader "Gender Gap in Science project".[50] These surveys provide invaluable data for tracking long-term changes and comparing the experiences of women in physics with those in other scientific disciplines.

Furthermore, WG5 has been instrumental in developing important policies, such as a Harassment Policy for IUPAP sponsored conferences and the Waterloo Charter, a declaration of principles and good practices for a more inclusive practice of physics.[50] The group also supports women in physics from developing countries through a travel grants program, enabling them to attend regional or international conferences, workshops, or schools that they might otherwise not access.[36] IUPAP's long-standing efforts demonstrate a global commitment to understanding and addressing gender inequality in physics, providing a crucial platform for data collection, international collaboration, and the dissemination of good practices. This sustained, organized, and international effort provides a valuable framework for national and institutional initiatives.

The L'Oréal-UNESCO For Women in Science Awards

Established in 1998, the L'Oréal-UNESCO For Women in Science International Awards aim to elevate the position of women in science by recognizing outstanding women researchers who have made significant contributions to scientific progress.[1, 46, 51] Each laureate receives a substantial grant of \$100,000 USD. The eligibility for these awards alternates annually between life sciences and physical sciences, mathematics, and computer science, ensuring recognition across diverse scientific domains.[46, 51] Notably, as of 2023, seven L'Oréal-UNESCO laureates have also been awarded a Nobel Prize in their respective fields.[46, 51]

This program serves as a vital mechanism for increasing the visibility of successful women in science, including physics. By showcasing exceptional women and their achievements, the awards directly contribute to eliminating gender stereotypes.[1] This provides crucial role models for aspiring female scientists, challenging the often-male-dominated image of science and inspiring future generations to pursue careers in these fields.

The "Gender Gap in Science: A Global Approach" Project

The "Gender Gap in Science: A Global Approach to the Gender Gap in Mathematical, Computing, and Natural Sciences: How to Measure It, How to Reduce It?" project was a comprehensive, three-year initiative funded by the International Science Council (ISC), undertaken by 11 international science unions, including IUPAP.[37, 46, 26, 50, 47] The project aimed to measure and reduce the gender gap across mathematical, computing, and natural sciences through a data-backed study on publications, a global survey of scientists, and a database of good practices.[46, 47]

Key findings from the project revealed that women's experiences in both educational and employment settings are consistently less positive than men's.[46, 47] A worrying statistic was that over a quarter of women's responses across the sciences reported experiencing sexual harassment at university or at work, with women being 14 times more likely than men to report personal harassment.[46, 47] Additionally, women consistently reported less positive relationships with their doctoral advisors.[46, 47]

The project's recommendations emphasized a multi-faceted approach: engaging families and communities, exploring socio-scientific issues, promoting social support through peer networks and mentorship, and developing leadership and communication skills for women and girls.[46, 47] A crucial warning from the project was that simply informing women and girls about STEM opportunities is unlikely to significantly close the gender gap unless other supporting strategies are implemented.[46, 47] This project represents a maturation of global efforts, providing comprehensive, multi-disciplinary data and emphasizing the need for systemic, culturally sensitive interventions beyond mere awareness campaigns, signaling a shift towards more effective and sustainable strategies. Its multi-faceted approach and collaboration across multiple science unions indicate a more robust and holistic understanding of the gender gap, moving beyond individual-level fixes to advocate for deeper, integrated interventions.

Other Promising Practices

Beyond these large-scale initiatives, various other promising practices are being implemented at institutional and local levels.

CERN's "25 by '25" Strategy: CERN, a leading international research organization, launched its "25 by '25" strategy in 2021. This aspirational target-based initiative aims to boost the gender and nationality diversity of CERN's staff and fellow population by 2025.[29] CERN also actively highlights women in science through various platforms, including videos featuring female scientists and social media campaigns, to inspire the next generation and promote diversity.[29]

Local Initiatives: Community-driven efforts play a vital role. "Women in Physics Lunches" provide informal settings within departments for students, postdocs, and professors to share ideas, experiences, and challenges, fostering a sense of community and support.[48] Similarly, Women in Physics groups on university campuses and Conferences for Undergraduate Women in Physics (CUWiP) offer crucial social support, mentorship, study sessions, social events, and workshops addressing challenges like imposter syndrome and graduate school applications.[26] These networks help improve women's physics experience and contribute to their feeling of belonging.

Professor Support: The role of individual physics professors is also essential. They can significantly encourage women and support them through challenges and instances of discrimination.[26] Their intervention can transform negative experiences into positive ones, demonstrating to women that they belong in physics.[26] Effective initiatives combine top-down institutional commitments (like CERN's targets) with bottom-up, community-driven support networks and strong individual mentorship, recognizing that comprehensive and lasting change requires action at multiple levels.

Actionable Recommendations for Sustainable Change

Addressing the persistent gender gap in physics requires a multi-faceted, sustained, and collaborative approach that targets systemic and cultural barriers across the entire academic pipeline.

Fostering Inclusive Cultures and Environments

To create truly equitable environments, physics departments and institutions must proactively dismantle existing cultural barriers. This involves promoting collaborative learning strategies and actively structuring group work to ensure equitable participation, for instance, by avoiding groups with exactly one woman and instead forming groups with two or more, or by implementing group-work contracts and assessing group outcomes to foster fair collaboration.[32, 34, 52]

Furthermore, it is imperative to implement comprehensive bias training and explicit anti-discrimination policies. This includes developing gender-transformative policies and programs that aim to level the playing field from early education through to the highest levels of decision-making.[1] Efforts must specifically address both explicit and implicit biases in hiring, evaluation, and promotion processes.[15, 5, 10]

A critical cultural shift involves moving away from an overemphasis on "brilliance" or "genius" as prerequisites for success. Instead, educators and supervisors should avoid using such terms and instead emphasize the importance of hard work, dedication, and the understanding that abilities can be developed through effort – a "growth mindset" which has been shown to benefit all students regardless of gender.[20, 25, 21]

Finally, creating robust social support systems, mentorship programs, and peer networks is essential. Physics departments should establish multiple avenues for women to seek and receive social support, including dedicated Women in Physics groups on campus, seminars and events discussing women's experiences, and formal mentorship programs.[26] Promoting social support for women and girls, such as peer networks and mentoring by more experienced STEM researchers or professionals, is a key recommendation from global studies.[46, 53, 47] Shifting physics culture requires a deliberate move from an individualistic, competitive, and "genius-centric" paradigm to one that values collaboration, growth, and inclusivity, actively dismantling the "hostile obstacle course" that currently impedes women's progress.[27, 29]

Enhancing Visibility and Role Models

To counter negative stereotypes and align the field with women's career values, it is crucial to actively curate and communicate narratives of successful, diverse women in physics. This means consistently highlighting the backgrounds, expertise, and passion of female scientists to inspire the next generation.[37, 45, 38] Such efforts should include showcasing women at all career stages, particularly in senior authorship roles, to demonstrate clear pathways for advancement.[10]

Furthermore, the societal impact and communal benefits of physics research must be explicitly highlighted. Embedding socially and personally relevant content in teaching and public outreach can be highly effective.[33, 14] This involves stressing how physicists contribute to solving critical social problems, such as cancer research, developing highly efficient photovoltaic cells, or addressing climate change issues.[18, 14, 30] This approach can particularly appeal to women, who often express higher communal goals in their career aspirations.[11, 33] By demonstrating how physics aligns with a desire to make a positive impact, more diverse talent can be attracted to the field.[22, 30]

Institutional and Policy Reforms

Sustainable change in physics necessitates a top-down commitment to systemic reform, moving beyond adhoc interventions to institutionalizing equity through transparent policies and accountability mechanisms. Institutions must adopt gender-transformative policies that actively level the playing field from early education through to the highest levels of decision-making.[1] This includes addressing inequities in research grants and promotion opportunities, where women are often disadvantaged.[1]

Ensuring transparent and equitable processes for hiring, promotion, and funding is paramount to counteract the "often invisible advantage for men" [15] and ensure fair treatment in career progression.[17] Rigorous monitoring and evaluation systems must be established and consistently applied to track progress, identify persistent gaps, and continuously improve gender equality initiatives.[37, 26, 27, 29] This approach moves beyond mere "box-ticking" to ensure genuine, data-driven accountability.

Finally, institutions must develop flexible work arrangements and supportive parental leave policies. While work-life balance arguments may be comparable across disciplines, women are disproportionately affected by career compromises for family reasons.[4, 6, 11, 21, 36, 41] Providing flexible working patterns and robust parental support systems can significantly alleviate these pressures, enabling women to sustain their careers in physics.[13, 53, 14, 30] This comprehensive approach to institutional reform is critical for dismantling traditional academic structures that disproportionately disadvantage women.

Early Intervention and Education

Interventions aimed at increasing women's participation in physics must begin much earlier in the educational pipeline, particularly at the high school level, to counteract the insidious effects of early socialization and stereotype threat before women self-select out of physics. High school is identified as a critical stage where there is the greatest ability to make a significant impact, as female students are still a "captive audience" in physics classrooms.[33, 14]

Evidence-based strategies for high school include "Recognition, Relevance, and Discussion".[33, 14] This involves publicly recognizing female students' abilities and contributions, directing other students to them for help, and holding high expectations of their capabilities. It also means embedding socially and personally relevant content in the curriculum, describing how physicists work on solving societal problems. Furthermore, open discussions about issues related to women's underrepresentation, such as implicit bias and social pressures, can mobilize students and reveal hidden equity issues.[33, 14]

It is essential to challenge gender stereotypes and build confidence from an early age. This requires addressing the internalization of negative messages that girls receive about their abilities in math and science.[1, 18, 30] Promoting a "growth mindset," where intelligence is seen as something that can be developed through effort, can significantly benefit girls and boys alike.[25, 50] Creating school environments where girls feel supported and accepted to take risks and learn from failure is crucial for fostering their interest and persistence in STEM.[22] Finally, pedagogical approaches in physics education should be reformed. While men may appreciate a more analytical approach, women often prefer more hands-on techniques.[11, 42] Early physics courses should move beyond purely lecture-based, surface-level learning to approaches that foster deeper understanding, which is often desired by girls from a young age.[8] Such reforms can make physics more engaging and accessible to a broader range of students, including women.

CONCLUSION: A COLLECTIVE PATH FORWARD

Reiteration of Complexity and Urgency

The underrepresentation and slow advancement of women in physics represent a complex, multi-faceted challenge. This disparity is driven by a confluence of factors, including perceived gender bias, the pervasive and detrimental "innate talent" stereotype, and unsupportive academic and workplace cultures, rather than solely by comparable work-life balance arguments.[15, 12, 20, 27, 21, 29] Progress in addressing this issue has been slow, and gains from well-intentioned initiatives often revert. This reversion is primarily due to the systemic nature of these deeply ingrained barriers, which necessitates fundamental organizational and cultural transformation rather than merely individual-level support.[8, 27, 29] The "hostile obstacle course" that women face within physics environments underscores the need for profound structural changes.

Emphasizing the Benefits of Diversity

Achieving genuine gender equality in physics is not merely a matter of social justice; it is a critical imperative for scientific excellence, innovation, and the global capacity to address pressing challenges like sustainable development.[1, 3, 7, 10, 16] Diverse scientific teams bring a wider array of perspectives and experiences, fostering creativity, reducing potential biases in research, and ultimately leading to more robust knowledge and impactful discoveries.[2, 3, 7, 16] Ensuring the full utilization of scientific talent, regardless of gender, is essential for maximizing human potential and effectively tackling the complex problems facing humanity.[1, 10, 26]

A Call for Sustained, Multi-faceted, and Collaborative Efforts

The ultimate success in closing the gender gap in physics hinges on a fundamental paradigm shift within the community. This shift involves moving from viewing diversity as an add-on or a problem to be "fixed" in women, to recognizing it as an integral component of scientific excellence and a shared responsibility requiring continuous, adaptive institutional change.

Sustainable change demands a holistic approach, integrating policy reforms, cultural shifts, pedagogical innovations, and robust support systems across all stages of the academic pipeline, from early education through to senior leadership.[37, 8, 26, 47] This is a collective responsibility, requiring sustained commitment from institutions, faculty, professional societies, and the broader scientific community.[1, 5, 10, 53] By fostering genuinely inclusive and equitable environments, physics can attract, retain, and fully leverage the talents of all individuals, ensuring a more vibrant, innovative, and impactful future for the discipline and for global progress.

REFERENCES

1. United Nations (n.d.). The Lack of Gender Equality in Science Is Everyone's Problem. Retrieved from <https://www.un.org/en/un-chronicle/lack-gender-equality-science-everyone%E2%80%99sproblem>
2. California Sea Grant (n.d.). Diversity in STEM: What it is, why does it matter, and how do we increase it?. Retrieved from <https://caseagrants.ucsd.edu/news/diversity-stem-what-it-why-does-it-matter-and-how-do-we-increase-it>
3. Society of Women Engineers (2024). Women in Engineering and STEM: A Review of the 2024 Literature. Retrieved from <https://swe.org/magazine/women-in-engineering-and-stem-a-review-of-the-2024-literature/>
4. Rueger, S. Y., & Cimpian, A. (2015). Men Evaluate Gender-Bias Research Less Favorably Than Women, Especially STEM Faculty. *Proceedings of the National Academy of Sciences*, 112(49), 15014–15019. Retrieved from <https://www.pnas.org/doi/10.1073/pnas.1510649112>
5. International Science Council (n.d.). Advancing gender equality in scientific organizations. Retrieved from <https://council.science/our-work/gender-equality/>
6. American Institute of Physics (2019). Women in Physics and Astronomy 2019. Retrieved from <https://www.aip.org/statistics/women-in-physics-and-astronomy-2019>
7. American Institute of Physics (n.d.). Women in Physics: Why so few?. Retrieved from <https://aip.brightspotcdn.com/3a/98/95f57b5ebeca16d1be7a7ad48a00/wominphys00.pdf>
8. Ivie, R., & White, S. (2012). Women in physics: A tale of limits. *Physics Today*, 65(2), 47–52. Retrieved from <https://pubs.aip.org/physicstoday/article/65/2/47/413914/Women-in-physics-A-tale-of-limits-A-newly-completed>
9. American Institute of Physics (n.d.). Challenges Facing Women in Physics Report. Retrieved from <https://aip.brightspotcdn.com/c0/02/7dab7ed543422d4ea1476f52c6b8/women-challenge-in-physics.pdf>
10. Porter, C., & Ivie, R. (2022). Long-term persistence of women in physics: A longitudinal study of undergraduate women in physics. *Physical Review Physics Education Research*, 18(1), 010115. Retrieved from <https://link.aps.org/doi/10.1103/PhysRevPhysEducRes.21.010115>
11. National Center for Science and Engineering Statistics (2021). Field of degree: Women. Retrieved from <https://nces.nsf.gov/pubs/nsf21321/report/field-of-degree-women>
12. Hallas, A., & Walls, A. (2025). Women in physics remain underrepresented — especially in Canada. *UBC Magazine*. Retrieved from <https://magazine.alumni.ubc.ca/2025/science/women-physics-remain-underrepresented-especially-canada>
13. Renken, E. (2016). Women in science tend to gravitate toward biology, cognitive sciences. *The Brown Daily Herald*. Retrieved from <https://www.browndailyherald.com/2016/03/16/women-in-science-tend-to-gravitate-toward-biology-cognitive-sciences>
14. Innovations Report (2009). Male physics departments no proof of bias in hiring women. Retrieved from <https://www.innovations-report.com/education/studies-and-analyses/male-physics-departments-proof-bias-hiring-women-217221/>
15. Deloitte (2019). Addressing the gender imbalance in life sciences today to secure a better tomorrow. Retrieved from <https://blogs.deloitte.co.uk/health/2019/03/addressing-the-gender-imbalance-in-life-sciences-today-to-secure-a-better-tomorrow.html>
16. American Physical Society (2020). Challenges Facing Women in Physics. Retrieved from <https://www.aip.org/statistics/challenges-facing-women-in-physics>
17. International Science Council (2020). Gender Gap in Science project: Findings published in report. Retrieved from <https://council.science/news/gender-gap-in-science-report/>
18. Pew Research Center (2018). 3. Women in STEM see more gender disparities at work, especially those in computer jobs, majority-male workplaces. Retrieved from <https://www.pewresearch.org/social-trends/2018/01/09/women-in-stem-see-more-gender-disparities-at-work-especially-those-in-computer-jobs-majority-male-workplaces/>

19. Zealousideal_Hat6843 (2023). Physics students of every gender, why do you think there are so few women in physics?. Reddit. Retrieved from https://www.reddit.com/r/PhysicsStudents/comments/11ly3wh/physics_students_of_every_gender_why_do_you_think/
20. Traxler, A. L., & Ivie, R. (2021). Physics, social interaction, single-sex environments, and femininity. *Physical Review Physics Education Research*, 17(1), 010114. Retrieved from <https://link.aps.org/doi/10.1103/PhysRevPhysEducRes.17.010114>
21. Leslie, S. J., Cimpian, A., Meyer, M., & Freeland, E. (2015). Expectations of brilliance underlie gender distributions across academic disciplines. *Science*, 347(6219), 262–265. Retrieved from <https://physicsworld.com/a/women-shun-fields-that-are-perceived-to-require-innate-ability/>
22. World Economic Forum (2015). Why we need to challenge beliefs about innate talent in STEM. Retrieved from <https://www.weforum.org/stories/2015/06/why-we-need-to-challenge-beliefs-aboutinnate-talent-in-stem/>
23. EdSurge (2024). For Girls to Succeed in STEM, Confidence Matters as Much as Competence. Retrieved from <https://www.edsurge.com/news/2024-10-17-for-girls-to-succeed-in-stem-confidencematters-as-much-as-competence>
24. Marchand, G. C., & Taasobshirazi, G. (2013). Stereotype Threat and Women's Performance in Physics. *Research in Science Education*, 43(5), 1959–1975. Retrieved from https://www.researchgate.net/publication/254316354_Stereotype_Threat_and_Women's_Performance_in_Physics
25. Marchand, G. C., & Taasobshirazi, G. (2019). Stereotype threat and women's performance on conceptual physics assessments. *AIP Conference Proceedings*, 2101(1), 010145. Retrieved from https://pubs.aip.org/aip/acp/article-pdf/doi/10.1063/1.5110145/14182402/120001_1_online.pdf
26. Porter, C., & Ivie, R. (2024). How women persist in undergraduate physics. *American Institute of Physics*. Retrieved from <https://www.aip.org/statistics/how-women-persist-in-undergraduatephysics>
27. Trejo, E., & Cech, E. A. (2024). Diversity interventions in academic STEM: A scoping review. *Studies in Higher Education*, 49(7), 1185–1203. Retrieved from <https://www.tandfonline.com/doi/full/10.1080/03075079.2024.2442052>
28. Garver, J. (n.d.). How It Went: Tackling Gender Bias and Barriers in STEM with Students. Knowles Teachers Initiative. Retrieved from <https://knowlesteachers.org/resource/how-it-wenttackling-gender-bias-and-barriers-in-stem-with-students>
29. Atadoga, M. M. (2016). Comparative Analysis of Gender Performances in Biology, Chemistry and Physics among Pre-Degree Students of Federal University Dutsinma. *International Journal of Education and Evaluation*, 5(1), 116–122. Retrieved from https://www.researchgate.net/publication/315761205_Comparative_Analysis_of_Gender_Performances_in_Biology_Chemistry_and_Physics_among_PreDegree_Students_of_Federal_University_Dutsinma
30. Traxler, A. L., & Ivie, R. (2024). Gender equity in physics labs: A review of the literature. *Physical Review Physics Education Research*, 20(1), 010102. Retrieved from <https://link.aps.org/doi/10.1103/PhysRevPhysEducRes.20.010102>
31. Hazari, Z., Sonnert, G., Sadler, P. M., & Shanahan, M. C. (2018). Gender differences in physics identity and career outcome expectations. *International Journal of Science Education*, 40(18), 2261–2279. Retrieved from <https://www.tandfonline.com/doi/full/10.1080/09500693.2018.1534021>
32. Al-Mousa, A., & Al-Zoubi, M. (2024). Gender Dynamics in Introductory Physics Laboratory Classes: An Analysis of Participation and Comfort Levels. *arXiv preprint arXiv:2405.15049*. Retrieved from <https://arxiv.org/html/2405.15049v1>
33. Global Souths Hub (2025). Exploring the Gender Gap: Women in STEM Today. Retrieved from <https://globalsouth.org/2025/03/exploring-the-gender-gap-women-in-stem-today/>
34. Bluefors (n.d.). Inspiring the Next Generation: Stories of Women in Physics Part 1. Retrieved from <https://bluefors.com/stories/inspiring-the-next-generation-stories-of-women-in-physics/>
35. RMI (n.d.). More Women in Science and Leadership for an Equitable Clean Energy Workforce. Retrieved from <https://rmi.org/more-women-in-science-and-leadership-for-an-equitable-cleanenergy-workforce/>
36. Xu, Y. J. (2016). Work–life balance and career satisfaction among college science, technology, engineering, and mathematics majors. *CBE—Life Sciences Education*, 15(1), ar1. Retrieved from <https://pmc.ncbi.nlm.nih.gov/articles/PMC4710394/>

37. Xu, Y. J. (2016). Work–life balance and career satisfaction among college science, technology, engineering, and mathematics majors. *CBE—Life Sciences Education*, 15(1), ar1. Retrieved from <https://pmc.ncbi.nlm.nih.gov/articles/PMC4710394/>
38. American Institute of Physics (2023). Physics and Astronomy Faculty Members' Well-Being During the COVID-19 Pandemic. Retrieved from <https://www.aip.org/statistics/physics-and-astronomy-faculty-members-well-being-during-the-covid-19-pandemic>
39. Ginther, D. K., & Kahn, S. (2014). The economics of women in STEM. *Issues in Science and Technology*. Retrieved from <https://issues.org/perspectives-2/>
40. Gentile, B., & Ivie, R. (2013). Why scientists think there are more women in biology than physics. *Gender & Society*. Retrieved from <https://gendersociety.wordpress.com/2013/09/13/why-scientists-think-there-are-more-women-in-biology-than-physics/>
41. Hodapp, T., & Hazari, Z. (2015). Women in Physics: Why so few?. *APS News*, 24(10), 8. Retrieved from <https://www.aps.org/publications/apsnews/201511/backpage.cfm>
42. American Association of University Women (n.d.). The STEM Gap. Retrieved from <https://www.aauw.org/issues/education/stem/>
43. Knowles Teachers Initiative (n.d.). Wonders of a Woman in Physics. Retrieved from <https://sciencepolicy.ca/posts/wonders-of-a-woman-in-physics/>
44. International Union of Pure and Applied Physics (n.d.). Working Group on Women in Physics. Wikipedia. Retrieved from https://en.wikipedia.org/wiki/Working_Group_on_Women_in_Physics
45. International Union of Pure and Applied Physics (n.d.). WG5: Women in Physics. Retrieved from <https://archive2.iupap.org/working-groups/wg5-women-in-physics/>
46. International Union of Pure and Applied Physics (n.d.). WG5: Women in Physics. Retrieved from <https://iupap.org/who-we-are/internal-organization/working-groups/wg5-women-in-physics/>
47. L'Oréal-UNESCO (n.d.). For Women in Science Awards. Retrieved from <https://www.unesco.org/en/prizes/women-science/awards>
48. L'Oréal-UNESCO (n.d.). L'Oréal-UNESCO For Women in Science Awards. Wikipedia. Retrieved from https://en.wikipedia.org/wiki/L%27Or%C3%A9al-UNESCO_For_Women_in_Science_Awards
49. CERN (2025). International Day of Women and Girls in Science 2025. Retrieved from <https://home.cern/news/news/cern/international-day-women-and-girls-science-2025>
50. Traxler, A. L., & Ivie, R. (2024). Gender equity in physics labs: A review of the literature.
51. *Physical Review Physics Education Research*, 20(1), 010102. Retrieved from <https://link.aps.org/doi/10.1103/PhysRevPhysEducRes.20.010102>
52. Al-Mousa, A., & Al-Zoubi, M. (2024). Gender Dynamics in Introductory Physics Laboratory Classes: An Analysis of Participation and Comfort Levels. arXiv preprint arXiv:2405.15049. Retrieved from <https://arxiv.org/html/2405.15049v1>
53. Ivie, R., & White, S. (2009). Number of Women in Physics Departments: A Simulation Analysis. American Institute of Physics. Retrieved from <https://www.innovations-report.com/education/studiesand-analyses/male-physics-departments-proof-bias-hiring-women-217221/>
54. Kulturel-Konak, S. (2022). Work-Life Balance and Well-Being of Women in STEM: A CrossCultural Study. *Sustainability*, 14(1), 357. Retrieved from <https://www.mdpi.com/20711050/14/1/357>
55. International Science Council (2020). Gender Gap in Science project: Findings published in report. Retrieved from <https://council.science/news/gender-gap-in-science-report/>
56. Atadoga, M. M. (2016). Comparative Analysis of Gender Performances in Biology, Chemistry and Physics among Pre-Degree Students of Federal University Dutsinma. *International Journal of Education and Evaluation*, 5(1), 116–122. Retrieved from https://www.researchgate.net/publication/315761205_Comparative_Analysis_of_Gender_Performances_in_Biology_Chemistry_and_Physics_among_PreDegree_Students_of_Federal_University_Dutsinma
57. User Query: User's initial query and follow-up abstract query