Physics

Background: The main purpose of this document is to assist reviewers who are involved in the appraisal of Physics research proposals but are not physicists themselves. It might also be usable in other contexts. The document lists a number of characteristics of physics as a scientific discipline, including its publication culture.
Research in physics is largely fundamental in its motivation and approach, but often with clear and strong links to applications.

The approach to research in terms of collaboration scale in physics varies significantly by subfield. At the small scale, high-impact research projects can be executed in the research group of a single principal investigator. Collaborations between theorists and experimentalists occur frequently, and in some cases, collaborations can extend to a handful of other research groups. On a medium scale, physicists work collaboratively through infrastructure-oriented institutes, such as beamlines and reactors, where individual or small scale collaborative experiments are executed using infrastructure shared among hundreds of researchers. At the largest scale, in high energy physics, where a single output, such as a publication, is the direct collaborative effort of tens up to thousands of international researchers.

Physics has strong links and borders with a large number of other disciplines, such as chemistry, biology, mathematics, astronomy and computer science as well as with many of the engineering fields. In some sub disciplines, this collaboration extends into life science and medicine.

All subfields of physics are involved in very strong, very frequent, and absolutely essential international collaborations, across Europe, North America, Asia, and worldwide. Physics transcends borders and International collaboration is a fundamental cornerstone of the research process in physics.
A large fraction of physics research relies crucially on the use and development of advanced infrastructure, required to push the boundaries of knowledge in physics. A key process in physics research is the development of new advances in infrastructure and detector technology, which nearly always goes hand-in-hand with the fundamental research.

Dutch physics groups range in size from a few people to typically about 20 people. In some fields and institutes, principal investigators (professors, associate professors, assistant professors) take an independent leading role in the research group (the “independent PI” model). These PIs themselves define the research direction in the group and directly supervise PhDs and postdoctoral researchers. In this context, a typical successful experimental group would be 4-10 PhDs/postdocs, plus the PI, in steady state. Theory groups can be smaller, consisting of a PI and a few students. In both cases, some groups can become quite large (> 20 PhDs postdocs per PI). In this context, researchers at all levels work together through bottom-up initiatives and collaborative grants. Larger research groups in which several senior physicists are in one group together with a common theme can also occur.

It is common in physics that papers from smaller-scale collaborations of works from individual research groups could have on the order 3 to 15 authors. At the large-scale end, especially in particle and astroparticle experimental physics, publications can include hundreds to thousands of authors recognising the contribution of all scientists in designing, building and analysing data from these large experiments. In many fields of physics, a “parabola order” list construction is employed, with the first author the one who was most directly involved in execution of the work, often a PhD / postdoc, proceeding with decreasing contribution for subsequent junior authors. Principle investigators are then listed in reverse order of contribution to the direction and supervision of the project, with the last author being the primary PI who was leading the project. This is not uniform across all subfields of physics, with a particular exception for the case of “big science” work in particle and astroparticle physics in which authors are listed alphabetically by last name.

The physics discipline is highly active in the dissemination of publications via the arXiv preprint server. In many fields, all publications are shared and disseminated via the arXiv, although in the vast majority of those cases,

the work on the arXiv is later published in peer-reviewed journals. The arXiv is also used as resource for demonstrating the order in which results are disseminated, bypassing delays in peer review. Conference proceedings in physics existed in the past, but little weight was given to them as a dissemination resource, with most of the important work disseminated via peer-reviewed journals and the arXiv. In fields of physics closer to applications, patents may also be an important medium for dissemination of results. In some subfields, publications in general journals like Science or Nature are not common and more weight is given to specialised journals.

In physics, developing new instruments, research infrastructure, highly complex experimental setups, and also new theoretical frameworks, can require a significant amount of time, and as a result, the publication output in some physics fields involving such development can be lower than average in the discipline, and sometimes vastly lower than in other disciplines. One significant difference we believe compared to many other disciplines is the high rate of embracement of the arXiv as a dissemination tool. Another significant difference, especially compared to biological disciplines, is in grant structure, where physicists are more likely to propose exploratory projects that can be judged on the strength of the ideas and the overall direction rather than preliminary data.