



The journals in physics that publish Nobel Prize research

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Abstract

We use the Nobel Foundations Scientific Background material to determine which journals have published Nobel Prize-awarded papers in physics since 1995. Analysing all references in the Nobel Prize Scientific Background material reveals that the journal Physical Review Letters published 28.5% of the Nobel Prize-awarded papers. It is followed by the Astrophysical journal, which accounts for 11.2%, Science, accounting 5.6% and Nature, accounting 4.7%. This is contrary to the journals respective Impact Factors, where Physical Review Letters and the Astrophysical Journal have much lower impact factors than Nature and Science. If works cited for background by the Nobel Foundation in the Scientific Background material are included in the analysis, the most referenced journal is still Physical Review Letters, now followed by Physical Review. The conclusion is that the most groundbreaking scientific work in physics is not necessarily published in the journals with the highest Impact Factor.

Keywords Nobel Prize · Physics · Citations · Journals · Impact Factor

Introduction

Every scientist knows that the journals that published scientific articles are not equally revered. Even though most scientific journals that publish peer-reviewed articles adhere to high academic standards, some journals are more highly regarded than others. The Impact Factor metric measures the impact of the papers published in a journal in terms of citations (Garfield 1955, 2006), and have often been used to quantify which journals have the highest regard in the scientific community.

However, there has also been criticism of the Impact Factor (Porta et al. 2003). It cannot be compared across different fields of science (Adam 2002), a few highly-cited papers can dominate the Impact Factor (Campbell 2008), and it can be artificially increased by for example requiring articles in a given journal to cite several works from the same journal (Falagas and Alexiou 2008; Carbone 2014).

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In this work, we consider the scientific articles within physics that resulted in that their authors was awarded the Nobel Prize, and use these to determine which journals that publish Nobel Prize-awarded work, and should thus be highly regarded in the scientific community. The Nobel Prize is, without question, the most prestigious award within science, and numerous scientific articles has discussed the details of how the Prize has been awarded. This includes analysis of impact, coauthorship and international collaboration patterns (Wagner et al. 2015; Chan et al. 2015), the affiliated institutions of Nobel Laureates (Schlagberger et al. 2016), the distribution between theoretical and experimental work (Karazija and Momkauskaitė 2004) and the pattern of awards by Nobel Laureates both before and after being award the Nobel Prize (Chan et al. 2014). The conclusion to these studies is that there is little to no difference in the international collaboration of Nobel Laureates (Wagner et al. 2015; Chan et al. 2015) compared to the scientific community as a whole, that most Laureates are affiliated with prestigious universities (Schlagberger et al. 2016) and that Nobel Laureates are more likely to have a theoretical compared to an empirical background (Chan and Torgler 2015).

The most investigated aspect of Nobel Laureates has been to determine at what age Nobel Laureates conduct their Nobel Prize-awarded research (Manniche and Falk 1957; Stephan and Levin 1993; Jones and Weinberg 2011; Baffes and Vamvakidis 1957; Bjørk 2019a). This age has been shown to differ between the respective fields (Manniche and Falk 1957; Bjørk 2019a; Chan and Torgler 2013). There is also a significant increase in the age of Nobel Laureates when they conducted their Nobel Prize research from 1901 until today. For physics this age increased by up to 13.4 years over the last century (Jones and Weinberg 2011), although the chance of being awarded the Nobel Prize still decreases dramatically after age 50 (Stephan and Levin 1993).

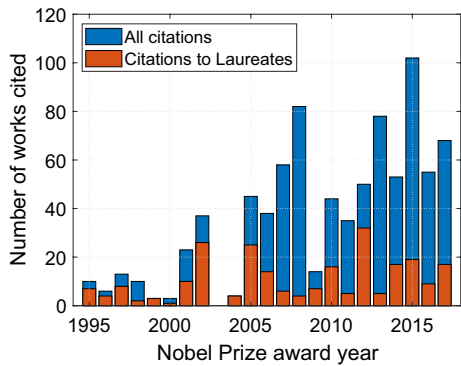
So far it has not been studied where Nobel Prize-awarded research is actually published, i.e. which journals publish this most ground-breaking and novel scientific work. It is interesting to investigate this, both to understand if Nobel Prize-awarded research is published in the most prestigious journals, but also to put the works of Nobel Laureates into perspective compared to that of other researchers.

Method and results

In order to establish which journals in physics publish Nobel Prize-awarded work, we consider the information made available by the Nobel Foundation for each awarded Nobel Prize. Specifically, the data considered here is the Scientific Background material published for the Nobel Prize in physics since 1995 and which is publicly available on the website of the Nobel Foundation. These documents contains references to the award-winning works of the Laureates, as well as references to background scientific works relevant for the awarded Nobel Prize. These references has previously been analyzed for all Nobel Prize fields to reveal the average age of Nobel Laureates when their Nobel Prize-awarded research was conducted, the number of works cited by the Nobel Foundation for each Laureate and the waiting time between conducting Nobel Prize-awarded research and receiving the Nobel Prize (Bjørk 2019a).

Here, we have determined the journals in which the Nobel Laureates in physics have published their Nobel Prize-awarded research. We consider only the field of physics, as the journals will obviously differ across different fields, and because of the intensity of the data analysis. The number of different works referenced by the Nobel Foundation in

Fig. 1 The number of works referenced in the Scientific Background material in physics as function of the year the Nobel Prize was awarded. Works by the Laureates are shown in red while all referenced works, include both the works of Laureates as well as background works, are shown in blue. (Color figure online)



the Scientific Background material for every year since 1995 is shown in Fig. 1. Note that in 2003, no specific works were cited in the Scientific Background material. As one can clearly see from the figure, it differs from year to year how many works are referenced in the Scientific Background material, but with the tendency that in recent years more and more works are cited. However, it is clearly a limiting factor in this study that there is no published Scientific Background material before 1995, and that for the period between 1995–2004, only a few publications were cited in the Scientific Background material. It is worth mentioning that the oldest work cited for background in the Scientific Background material is W. Thomson’s ”On the Electro-Dynamic Qualities of Metals: Effects of Magnetization on the Electric Conductivity of Nickel and of Iron“, published in Proc. R. Soc. Lond. A in 1856.

The data set used in the analysis, which contains the number of citations to individual journals both as function of the year that the Nobel Prize was awarded and as function of the publication year, is publicly available (Bjørk 2019b).

Where do Laureates publish?

Initially, we only consider the publications by the Nobel Laureates and not the works cited for scientific background. In total there are 241 references to the work of the Nobel Laureates in the Scientific Background material published by the Nobel Foundation since 1995 in physics. These references cover a total of 54 unique journals. The cumulative sum of references to the individual journals are shown as a function of the year that the Nobel Prize was awarded in Fig. 2a for the six journals with most citations. Over all years considered, the journal that has published most Nobel Prize-awarded papers is by far Physical Review Letters. This journal has published 28.5% of all works by Nobel Laureates cited in the Scientific Background material. Interestingly, the Astrophysical Journal is the second most cited journal, surpassing both Nature and Science. It is also interesting to note that a single journal, Jpn. J. Appl. Phys., is only cited for the Nobel Prize awarded in 2014, but here received so many citations that it is still able to appear in the list of top six journals.

As the Nobel Prize can be awarded for both recent and older work, it is also of interest to investigate how the citations in the Scientific Background material to different journals are distributed with respect to the publication year of the Nobel Prize-awarded works. This is shown in Fig. 2b. The trend of the data remains the same as for Fig. 2a. Regarding the time aspect of Fig. 2, it is interesting to see how certain journals are only cited for a single

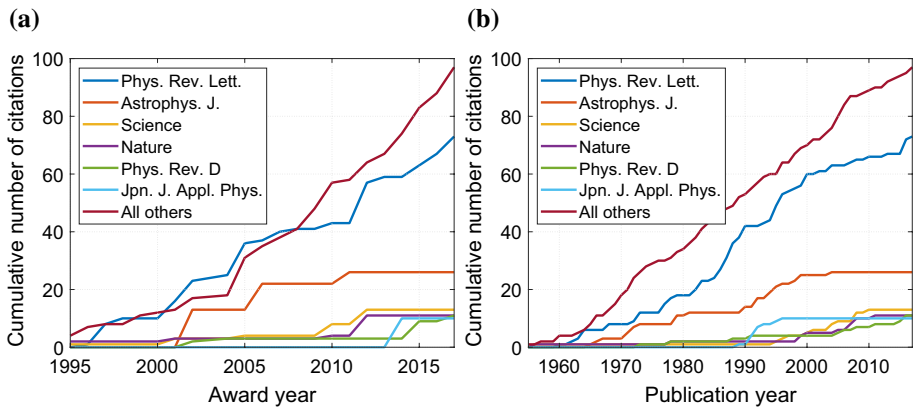


Fig. 2 The cumulative sum of the number of citations to Nobel Laureates Prize-awarded work as function of **a** the year the Nobel Prize was awarded and **b** the year the publication was published

or over a few years, whereas other journal are cited more consistently. It is also interesting to see that the high impact journals such as Nature and Science are not cited for every awarded Nobel Prize, but are cited much more irregularly and infrequently.

Where are background works published?

So far we have only considered the publications of the Nobel Laureates themselves, and not the scientific publications cited for background information in the Scientific Background material. We now consider the citations to all journals, including both the work of the Nobel Laureates and the scientific background publications. The cumulative sum of citations is shown as a function of the year that the Nobel Prize was awarded in Fig. 3a. The number of unique journals increases from 54 for the Nobel Laureates alone to 146 when

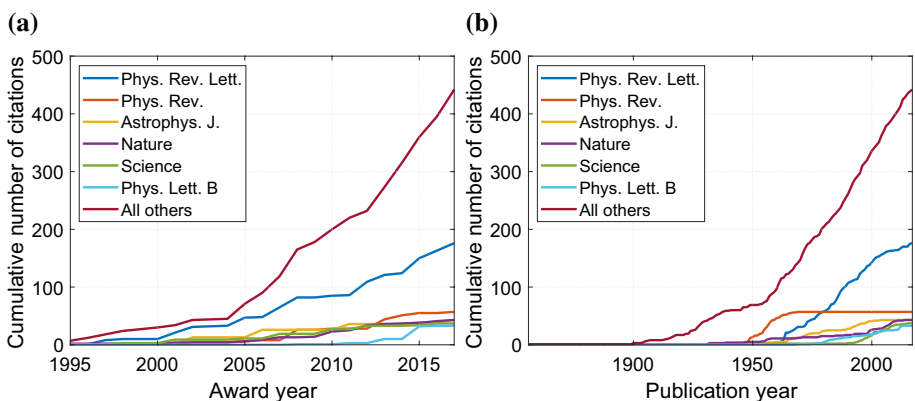


Fig. 3 The cumulative sum of the number of citations to both the work of the Nobel Laureates and the scientific background publications as function of **a** the year the Nobel Prize was awarded and **b** the year the publication was published

the background papers are included. The total number of publications cited in the Scientific Background material also increases to 831. The six most cited journals now include the no-longer published journal Physical Review, but the list is still dominated by Physical Review Letters.

The time aspect of Fig. 3 shows a similar trend as for Fig. 2, i.e. most journals are cited irregularly from year to year. The only journal for which this is not the case is Physical Review Letters, which is cited in the Nobel Prize Scientific Background material almost every year. It is also interesting to see in Fig. 3b that as function of publication year, Physical Review is clearly the most cited journal until 1969, where it was no longer published, and after which Physical Review Letters takes over.

Impact Factor

It is worth exploring whether there is a correlation between the Impact Factor of journals and the degree to which they publish research cited by the Nobel Foundation. To explore this, we consider the years 1995–1999 as this is the five-year period with the highest number of cited works from both Nobel Laureates and background scientific publications in the Scientific Background material. The time between conducting the Nobel Prize-awarded research and being awarded the Nobel Prize is on average 23.5 ± 14.0 years in physics (Bjørk 2019a), which means that publications after this period have not fully had time to be cited in the Nobel Prize Scientific Background material, i.e. future Nobel Prizes will likely be awarded for scientific discoveries conducted after this period. A total of 85 Nobel Prize-awarded works and background articles were published from 1995–1999. Of these 34 were Nobel Prize-awarded works from Laureates. We have considered the six journals mentioned in Fig. 2 and obtained their historical Impact Factors for this period from the Journal Citation Reports (JCR) from Clarivate Analytics. Figure 4 shows the percentage of citations to these six journals in the Nobel Prize Scientific Background material compared to the average Impact Factor for the six journals over the period 1995–1999. As can be seen from the figure, there is no correlation between the Impact Factor and the percentage of citations in the Nobel Prize Scientific Background material.

It is of interest to expand the above analysis to investigate if the journals with the highest Impact Factor specialized in physics publish the most Nobel Prize-awarded research, i.e. repeating the above analysis with the comprehensive journals Nature and Science excluded. To expand the number of journals investigated, we now consider the journals

Fig. 4 The percentage of citations for six respective journals in the Nobel Prize Scientific Background material compared to their average Impact Factor over the period 1995–1999. The error bars on the Impact Factor indicate the standard deviation of the Impact Factor over the period

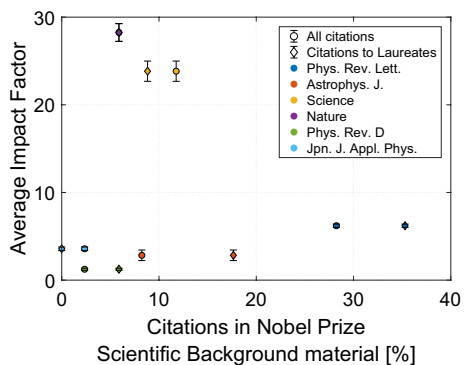
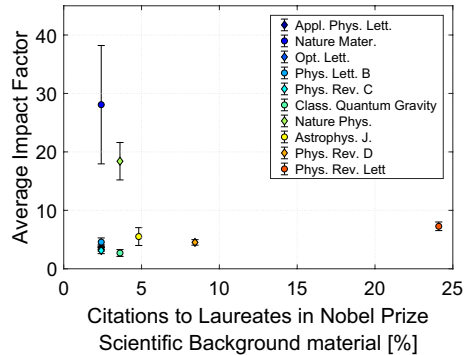


Fig. 5 The percentage of citations to Laureates for the ten specialized journals which published a minimum of two Nobel Prize-awarded works in the period from 1997 until 2017 compared to their average Impact Factor over the same period. The error bars on the Impact Factor indicate the standard deviation of the Impact Factor over the period



that are specialized in physics or astronomy and that within the period 1997–2017 published a minimum of two Nobel Prize-awarded works by Laureates—this amounts to ten journals. As argued above, because of the waiting time for the Nobel Prize, more works in this time period will probably be cited by the Nobel Foundation in Nobel Prizes awarded in the near future. Figure 5 shows the percentage of citations to these ten journals in the Nobel Prize Scientific Background material compared to their average Impact Factor for the period 1997 until 2017. As can be seen from the figure, there is no correlation between the Impact Factor and the percentage of citations in the Nobel Prize Scientific Background material also for these specialized journals. It should be noted however, that that the journal Nature Materials was not published before 2002 and the journal Nature Physics was not published before 2005 thus these naturally have fewer citations in the Scientific Background material.

Discussion

The above analysis is logically followed by the question of why is it that journals with high Impact Factors, such as Nature and Science, are cited more irregularly and infrequently in the Scientific Background material. The answer to this is clear from the analysis, namely that novel and important works in physics are not preferentially published in the highest Impact Factor journals but rather in more specialized journals. However, the reason for this trend cannot be deduced from the presented data. Although speculative, the explanation for this is likely historical, as Physical Review has traditionally been *the* journal where new discoveries in physics are published, and that remains true today. This means that if the Impact Factor could be computed in a field-specific way, the physics-specific Impact Factor for Nature and Science would be much smaller than their general Impact Factors—or said in another way, it is not publications and citations within physics that results in the high Impact Factor of general journals like Nature and Science.

Conclusion

In conclusion, using the Scientific Background material published by the Nobel Foundation for each awarded Nobel Prize in physics since 1995, we have determined in which journals Nobel Laureates in physics publish their Nobel Prize-awarded work. The journal

that published most Nobel Prize-awarded articles is by far Physical Review Letters, which published 28.5% of the Nobel Laureate papers cited in the Scientific Background material. Interestingly, Physical Review Letters, as well as the Astrophysical Journal, which is the second most cited journal, both have lower Impact Factors than Science and Nature, which are ranked third and fourth, respectively. If all background scientific articles cited by the Nobel Foundation, i.e. including the articles not authored by the Nobel Laureates, are analyzed the most cited journal is still Physical Review Letters, now followed by Physical Review, a journal that was last published in 1969. The final conclusion is that in physics the most ground-breaking scientific works are not necessarily published in the highest impact journals, but rather in more specialized physics journals.

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