10-31-2022

Which countries are leading high-impact science in astronomy?

Juan P. Madrid

Draft version December 5, 2022
Typeset using LaTeX default style in AASTeX62

Which countries are leading high-impact science in astronomy?

Juan P. Madrid[1]

[1] *Department of Physics and Astronomy, The University of Texas Rio Grande Valley, Brownsville, TX 78520, USA*

ABSTRACT

Recent news reports claim that China is overtaking the United States and all other countries in scientific productivity and scientific impact. A straightforward analysis of high-impact papers in astronomy reveals that this is not true in our field. In fact, the United States continues to host, by a large margin, the authors that lead high-impact papers. Moreover, this analysis shows that 90% of all high-impact papers in astronomy are led by authors based in North America and Europe. That is, only about 10% of countries in the world host astronomers that publish "astronomy's greatest hits".

1. INTRODUCTION

Recent news reports claim that China is overtaking the United States in scientific research output and in particular high-impact papers[1]. Several news sources quote a report from the National Institute of Science and Technology of Japan that found that in recent years, China has been publishing not only the highest number of scientific research papers, but also the most cited ones, overtaking all other countries including the United States[2]. Is this true for astronomy?

2. METHODS

In the NASA Astrophysics Data System (ADS) our field has a pioneering digital library (Kurtz et al. 2000; Accomazzi et al. 2015). The ADS gives us access to a wide range of bibliographic information with just a few clicks. The capabilities of the ADS have been routinely used to evaluate the productivity and impact of individual astronomical observatories, e.g. Lick (Smith & Shetrone 2020), Spitzer (Scire et al. 2022), Chandra (Blecksmith et al. 2005), and HST (Meylan et al. 2004).

A simple ADS query, resolved in a fraction of a second, will reveal the most cited papers for any given year. Using the ADS, we ranked all papers published in the year 2020 by the number of citations. Why 2020? We must wait for at least a year for papers to gather citations but we also want to have the most recent values (Meylan et al. 2004).

We kept tabs on the author's affiliation for the first author, or the corresponding author, for these 100 most cited astronomy papers, published in 2020. These are the papers that can be considered to have the most influence in the field, or "Astronomy's Greatest Hits" (Frogel 2010). Crediting papers to the host country of the first author has been used as a straightforward method to estimate the impact of astronomical research from different countries (Sánchez & Benn 2004).

Publications with the highest impact accumulate a large number of citations within the first year. Indeed, a limited number of papers swiftly accumulate a very large quantity of citations. The 100 most cited papers (published in 2020) constitute only 0.1% of the total records indexed by the ADS for that year but represent 11% of the total citations. For those mathematically inclined, the distribution of citations for papers published in a given year, is well described by a declining exponential (Madrid et al. 2006).

Each of these 100 high-impact papers count for 1% of the total in Table 1. What if a paper has two corresponding authors from two different countries? We allocated 0.5% for each country, which explains the fractional values.

[1] Japan falls out of top 10 nations with most-cited scientific papers Fujinami, Y. The Asahi Shimbun (August 2022) https://www.asahi.com/ajw/articles/14691980

[2] China overtakes the US in scientific research output. Lu, D., The Guardian (August 2022) https://www.theguardian.com/world/2022/aug/11/china-overtakes-the-us-in-scientific-research-output

3. RESULTS

Scientists based in the United States published the largest share of high-impact papers in 2020, that is, 36% of the total. The United States is followed by Germany and the United Kingdom both publishing 9.5% of the total. If all countries belonging to the the European Union are added together they would represent 36% of the total of high-impact papers (excluding the UK). European countries that do not appear in Table 1 but that have a contribution to the most cited papers are: Belgium (2%), Denmark, Hungary, Poland, and Sweden all with 1% of the total, and Czechia with 0.5%.

The most influential work in astronomy is overwhelmingly led by scientists based in the "North Atlantic". That is, 90% of all high-impact papers in Astronomy are led by authors based in North America and Europe. Contrary to recent reports, China only leads 2.5% of all high-impact papers for the year we evaluated. This work also highlights the disparity across the world when it comes to game-changing scientific work: only 13% of all countries in the world (25 out 193) host scientists that pilot the top 100 high-impact papers.

For the year 2020, the statistics of high-impact papers were shaped by the results of the Planck mission and the LIGO-Virgo collaboration. The cosmological parameters published by the Planck collaboration, at almost 8,000 citations, is the most cited paper for that year (Planck collaboration 2020).

Table 1. High-Impact Papers by Country

Rank	Country	%
1	USA	36.0%
2	Germany	9.5%
3	UK	9.5%
4	Italy	7.6%
5	France	4.2%
6	Canada	4.0%
7	The Netherlands	3.5%
8	Switzerland	3.0%
9	Spain	2.7%
10	China	2.5%

REFERENCES

Accomazzi, A., Kurtz, M. J., Henneken, E. A. et al. 2015, ASP Conference Series, Vol. 492 San Francisco: Astronomical Society of the Pacific, p.189

Blecksmith, S., Bright, J., Rots, A. H., et al. 2005, adass XIV, 347, 380

Sánchez, S. F. & Benn, C. R. 2004, Astron. Nachr. 325, 445

Frogel, J. A. 2010, PASP, 122, 1214

Kurtz, M. J., Eichhorn, G., Accomazzi, A., Grant, C. S., Murray, S. S., Watson, J. M. 2000, A&AS, 143, 41

Madrid, J. P. & Macchetto, F. D. 2006, Bulletin of the American Astronomical Society, Vol. 38, p. 1286

Meylan, G., Madrid, J. P., & Macchetto, D. 2004, PASP, 116, 790

Planck collaboration, 2020, A&A, 641, 6

Scire, E., Rebull, L., & Laine, S. 2022, PASP, 134, 055001

Smith, G. H. & Shetrone, M. 2020, PASP, 132, 125002