

Publication statistics on Sun and heliosphere

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Abstract The professional literature provides one means to review the evolution and geographic distribution of the scientific communities engaged in solar and heliospheric physics. With help of the Astrophysics Data System (NASA/ADS), I trace the growth of the research community over the past century from a few dozen researchers early in the 20-th Century to over 4,000 names with over refereed 2,000 publications in recent years, with 90% originating from 20 countries, being published in 90 distinct journals. Overall, the lead authors of these publications have their affiliations for 45% in Europe, 29% in the Americas, 24% in Australasia, and 2% in Africa and Arab countries. Publications most frequently appear (in decreasing order) in the *Astrophysical Journal*, the *Journal of Geophysical Research (Space Physics)*, *Solar Physics*, *Astronomy and Astrophysics*, and *Advances in Space Research* (adding up to 59% of all publications in 2015).

Keywords: publications; sociology of astronomy

1. Trends in the research community and its publications

Schrijver *et al.* (2016) reviewed the publication statistics on research related to Sun and heliosphere starting in 1911 and ending in 2014. They did so on the occasion of the reorganization of the Commission structure of the International Astronomical Union which formally ended its Commission 10 on “Solar Activity”. Schrijver *et al.* (2016) analyzed the activity of the research community using the tools provided by the Astrophysics Data System (ADS²), which enables searches over all the major trade publications in astrophysics in general. They reviewed the number of refereed publications per year going back over a century, and quantified the population of active researchers and their publication productivity. In the remainder of this Section only, I use their results and largely their wording and conclusions, but updated the figures and other results to include 2015 and added comments on the trend changes in the mid-1970s.

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²URL: http://adsabs.harvard.edu/abstract_service.html

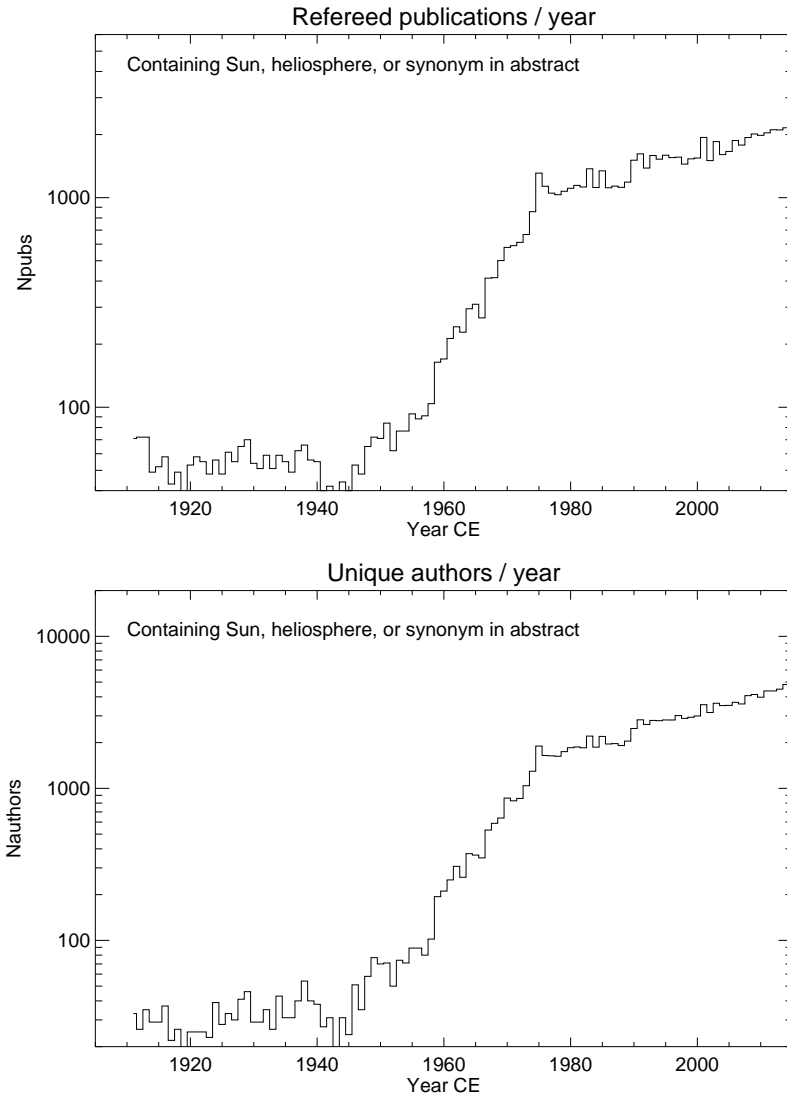


Figure 1. Number of refereed publications per year with abstracts focusing on Sun or heliosphere (*top*) and number of unique authors for each year in publications per year with abstracts focusing on Sun or heliosphere (*bottom*), as returned by ADS. (After Schrijver *et al.*, 2016, updated through 2015)

The study of phenomena related to “solar activity” often involves other aspects of the Sun (such as internal dynamics, dynamo, or surface field patterns) and they are obviously not limited to the Sun but drive phenomena throughout the heliosphere. Schrijver *et al.* (2016) therefore do not separate by research disciplines, but searched ADS for abstracts of refereed publications in the “Astronomy” database, either mentioning the Sun or heliosphere or their synonyms. They filtered out at least many of the papers that do not deal with

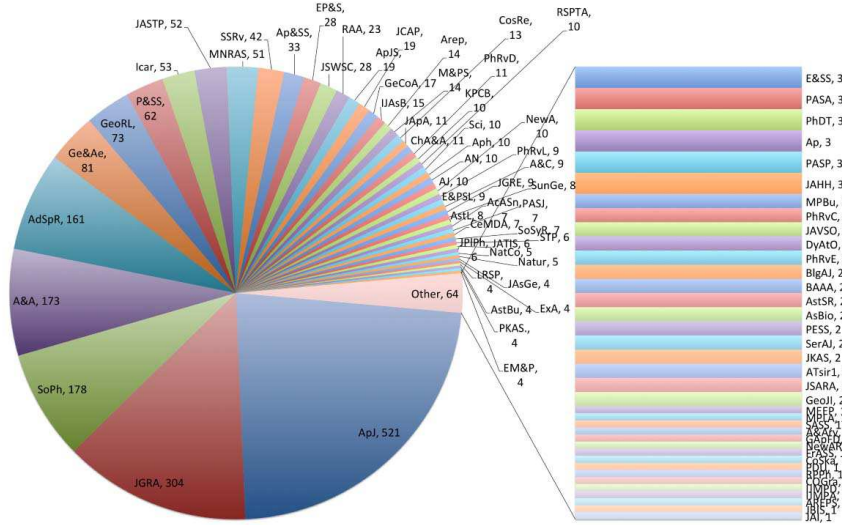


Figure 2. Number of refereed publications in 2015 on solar or heliospheric topics sorted by refereed journal. The standard abbreviation of the journal name (http://adsabs.harvard.edu/abs_doc/refereed1.html) is followed by the number of selected publications (see caption to Fig. 3 for the names of the top 10).

Sun/heliosphere that come into the search results because their abstracts include, for example, a unit like “solar mass”; to do so, they excluded abstracts that contain one or more of the following words or word groups: cluster, dwarf, extrasolar, galaxy, gravitational, ice, kpc, solar system, stellar, binary, sunset, sunrise, eclipse, solar cell, solar occultation, interstellar medium, and supernova.

The ADS searches suggest that the productivity of the world-wide community researching the Sun and heliosphere continues to grow steadily when measured through its publications (top panel in Figure 1). A rapid growth in the number of refereed publications that started after the Second World War continued up to about 1975. After that, the growth slowed drastically, transitioning to a sustained increase that doubles the number of refereed publications on a time scale of approximately 40 years, reaching a total of 2285 publications by 2015. This change (very similar to, for example, results obtained when looking for refereed publications with “star” or synonyms in the abstract; not shown here) is not likely to be an artefact of incompleteness of the ADS data bases, because these go back to first volumes of the most important journals, i.e., Astrophysical Journal (from 1895 onward), Solar Physics (from 1967 onward), and Astronomy and Astrophysics (from 1969 onward)³.

There are doubtlessly multiple reasons for the pronounced change in the publication growth rate around 1975, but assessing these is beyond the scope

³http://adsabs.harvard.edu/journals_service.html

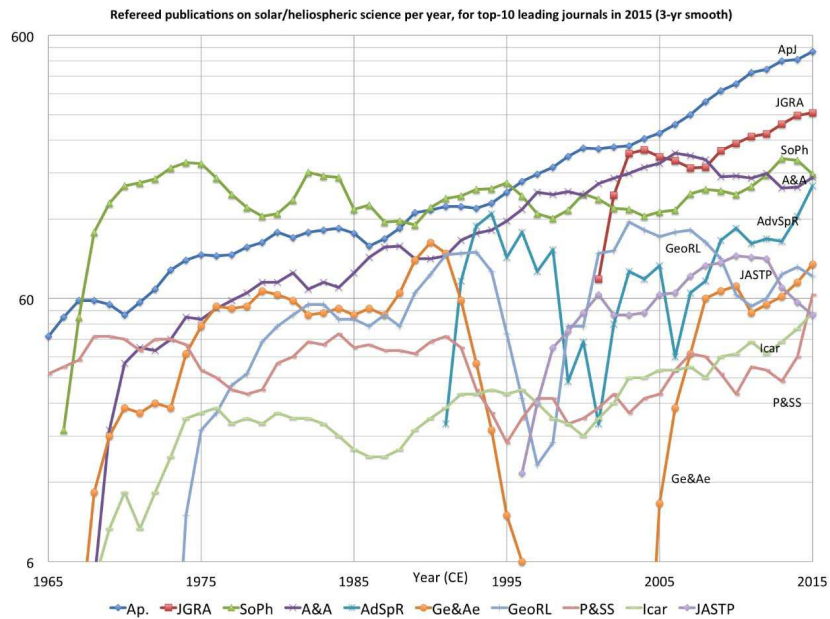


Figure 3. Number of refereed publications per year (after 3-yr smoothing) on solar or heliospheric topics that appeared in the past 50 years in the top-10 journals with most such publications in 2015: Astrophysical Journal (ApJ; with 521 publications in 2015), Journal of Geophysical Research Space Physics (JGRA; 304 publications), Solar Physics (SPH; 178), Astronomy and Astrophysics (A&A; 173), Advances in Space Research (AdvSpR; 161), Geomagnetism and Aeronomy (Ge&Ae; 81), Geophysical Research Letters (GeoRL; 73), Planetary and Space Science (P&SS; 62), Icarus (Icar; 53), and Journal of Atmospheric and Solar-Terrestrial Physics (JASTP; 52).

of this paper. One substantial determining factor noted here, however, can be inferred from the U.S. federal budgets. Among other statistics, federal spending in nondefense research and development from 1953 onward as tracked by the AAAS⁴ shows the rapid increase in post-WW II spending, peaking in the second half of the 1960s (including support for the fast-track Apollo project and its human exploration of the Moon), then decreasing to level off at a roughly constant funding when expressed in inflation-corrected units.

In automated searches as used here it is not readily possible to avoid some distortion of the statistics associated with the author names. For one thing, authors with identical family names and initials for their given names are not differentiated. Also, authors who publish with different spellings or composites of their family names (*e.g.* married and maiden names) or their initials will be counted as separate individuals. However, these effects are expected to have limited impacts on relative trends.

The number of unique author names contributing to refereed publications shows a trend (shown in the bottom panel in Figure 1) that roughly mimics that

⁴<http://www.aaas.org/page/historical-rd-data>

Table 1. Number of refereed publications on solar and heliospheric physics grouped by country of the affiliation of the lead author, sorted by decreasing number.

USA	567	China	262	Russia	228	UK	126
Germany	112	India	110	France	84	Japan	74
Italy	67	Spain	49	Finland	35	Korea	34
Belgium	33	Czech Republ.	28	Norway	27	Sweden	27
Brazil	24	Ukraine	23	Poland	23	Switzerland	18
Austria	16	Canada	15	Australia	15	Greece	12
Mexico	11	Bulgaria	10	South Africa	9	Nigeria	9
Argentina	8	Hungary	8	Iran	8	Thailand	8
Slovakia	7	Turkey	7	Taiwan	6	Ethiopia	6
Egypt	5	Malaysia	4	Chile	4	Ireland	4
Denmark	4	Georgia	4	Israel	3	New Zealand	3
the Netherl.	3	Uganda	3	Croatia	3	Azarbaijan	2
Pakistan	2	Armenia	2	Romania	2	Portugal	2
Kenya	1	Algeria	1	Oman	1	Iraq	1
Slovenia	1	Venezuela	1	Cyprus	1	Saudi Arabia	1
Costa Rica	1	Colombia	1	Indonesia	1	Serbia	1

of the number of publications; after about 1975, the growth rate of the author population of $\approx 2.5\%/yr$ is about twice the growth rate of the world's overall population (which averaged at $\approx 1.3\%/yr$ over the same period; Population reference bureau, 2013).

2. Distribution over journals

In 2015, ADS returned a total of 90 distinct refereed journals (plus a few PhD theses that also qualify as refereed publications but are likely underrepresented in the data base) with publications on solar and heliospheric topics. Figure 2 shows the distribution over the journals, sorted by decreasing number of publications in that year, using the standard abbreviations as used by ADS⁵.

The top ten by number of publications in 2015 together contain about 73% of all selected publications. Figure 3 shows the evolution of the number of papers in this top-10 over the past half century (after a 3-yr smoothing to dampen fluctuations and for easier viewing of the results). Note the relatively flat number of publications in Solar Physics since about 1970 compared to the sustained growth in that number in the Astrophysical Journal. Also note that the predominant journal for solar and heliospheric science changed from Solar Physics to the Astrophysical Journal around the early 1990s, and that JGRA and A&A overtook Solar Physics in the first years of this millenium. Astronomy and Astrophysics shows a relative growth in the rate of solar and heliospheric publications similar to that in the Astrophysical Journal from the early 1970s through 2006, after which a declining trend sets in over the past decade.

⁵http://adsabs.harvard.edu/abs_doc/refereed.html

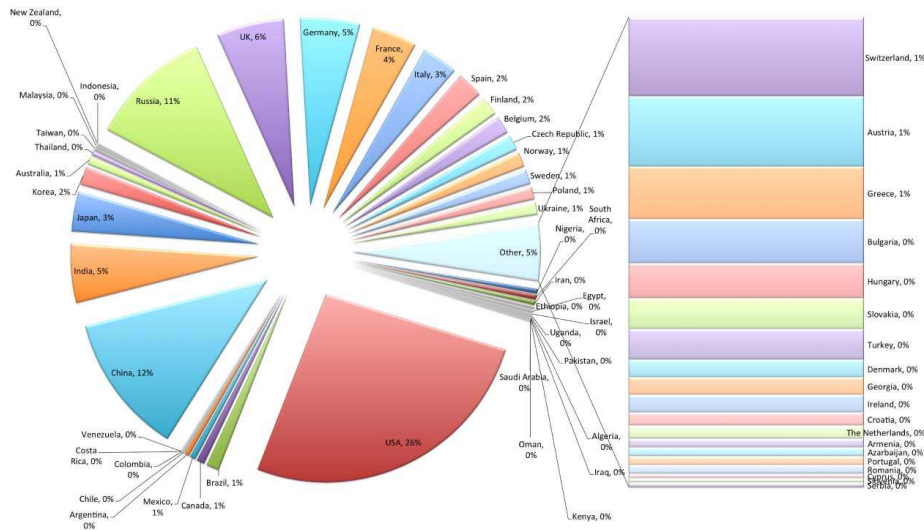


Figure 4. Distribution of the number of refereed publications on solar and heliospheric physics grouped according to the country for the affiliation of the lead author, sorted by fraction of the total (shown in percent). The countries are shown sorted by general geographic region (clockwise from the top): Europe, Africa and the Arab region, Americas, and Australasia.

3. Nationalities of affiliations of lead authors

ADS also enables a review of the affiliations of the lead authors of the refereed publications in ADS for 2015 on solar and heliospheric sciences and their use in other publications. When grouped by country for the affiliation of the lead author, and sorted by decreasing number of papers, the list of 64 countries results shown in Table 1. Funding agencies and national Academies of science are involved through first authors in 7.4% of all papers from NASA in the USA, and generally more than 50% in China, Russia, and the former republics of the USSR (where the Russian Academy of Sciences includes about 60% of all scientific organizations).

When sorting affiliations of lead authors by general geographic region the following publications statistics result (see Figure 4): from Europe (including Russia): 969 (45% of the total); from the Americas: 632 (29%); from Australasia: 517 (24%); from Africa and Arab countries (to Pakistan): 50 (2%).

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