The Rise and Citation Impact of astro-ph in Major Journals

Travis S. Metcalfe

High Altitude Observatory, National Center for Atmospheric Research,
P.O. Box 3000, Boulder, CO 80307-3000 USA

Abstract

The rise in the use of the arXiv preprint server (astro-ph) over the past decade has led to a major shift in the way astronomical research is disseminated. Schwarz & Kennicutt (2004) recently found that Astrophysical Journal papers posted to astro-ph are cited roughly twice as often as papers that are not posted, suggesting that the preprint server has become the primary resource for many astronomers to keep up with the literature. I describe a simple method to determine the adoption rate and citation impact of astro-ph over time for any journal using NASA’s Astrophysics Data System (ADS). I use the ADS to document the rise in the adoption of astro-ph for three major astronomy journals, and to conduct a broad survey of the citation impact of astro-ph in 13 different journals. I find that the factor of two boost in citations for astro-ph papers is a common feature across most of the major astronomy journals.

1 Motivation

Schwarz & Kennicutt (2004) recently conducted a detailed study of papers published in the Astrophysical Journal (ApJ), designed in part to document the adoption rate and citation impact of the arXiv preprint server (astro-ph; Ginsparg 2001). The database they constructed for this study is a rich source of demographic and citation information for the ApJ, but the two most interesting results were specific to astro-ph. They found that the adoption rate of astro-ph varied widely between subfields of astronomy, with nearly universal adoption (95%) in cosmology and the lowest adoption (22%) in solar astrophysics and planetary science by 2002. This difference among subfields is significant because they also found that papers posted to astro-ph are cited about twice as often as papers that are not posted. This boost in citation rates was more than a factor of 10 for cosmology papers, and still a factor of 1.8 for papers in solar astrophysics and planetary science.

Considering the main findings of Schwarz & Kennicutt about ApJ papers, I wondered whether the other major journals would show similar trends. Is astro-ph as widely used by author communities in other parts of the world? Does astro-ph produce a comparable impact on the citation rates for papers published in the other journals? Answering these narrow questions for a large sample of journals is considerably easier than the deep study undertaken by Schwarz & Kennicutt for the ApJ. The Astrophysics Data System (ADS; Kurtz et al. 2000) recently added links to the arXiv preprint records of journal papers that have also been posted to astro-ph. This new feature, combined with the citation data and search filtering capability of ADS, allows users to measure the adoption rate and citation impact of astro-ph for each journal with just a few clicks.

In this short paper, I document the rise in the adoption rate of astro-ph for three major astronomy journals published in North America (ApJ), the UK (MNRAS), and continental Europe (A&A). I also determine the citation impact of astro-ph on papers published in 2002 for 13 journals spanning the globe. I describe in section 2 how to generate these statistics for any journal using the ADS, and I validate the method by comparing it to the Schwarz & Kennicutt sample. I present and discuss the main results in section 3, and I summarize the major conclusions in section 4.

2 Methodology

For any given range of dates and for any particular journal in the ADS, statistics on the fraction of papers posted to astro-ph (the adoption rate) and the resulting impact on the citation rate (the citation impact) can be generated with two simple queries. For example, generating statistics that can be compared to the Schwarz & Kennicutt sample requires the following: (1) Enter a Publication Date range between 7/1999 and 12/1999. (2) Under the filters section Select References From, choose All refereed publications and type the journal code “ApJ.” in the select/deselect publications field. (3) For the first query, set Select References With to A bibliographic entry (the default). For the second query, set it to All of the following and check ArXiv Preprint. (4) Under the sorting section, select Sort by citation count. In the query results, just above the bibliographic entries, the first query yields the total number of ApJ papers published in this date range and the total number of citations to those papers in the ADS database (which is not complete, but includes data from all of the major journals beginning in 1999). The second query yields the corresponding numbers for the subset of these papers that have also been linked to an astro-ph record.

In this example, the first query results in Total number selected: 1182, Total citations: 29904, while the second query gives Total number selected: 706, Total citations: 22623. This means that the totals for non-astro-ph papers are 476 and 7281 respectively. Since these queries return papers published as Letters and Main Journal articles together, and because additional citations have now been added to ADS, the results are not strictly comparable to the Schwarz &
Kennicutt sample. Even so, the fraction of ApJ articles posted to astro-ph from these queries (706/1182 = 60\%) is nearly identical to that found for Main Journal articles by themselves (61\%; Schwarz & Kennicutt 2004, their Table 4). In addition, the mean number of citations for astro-ph papers (22623/706 = 32.0) compared to non-astro-ph papers (7281/476 = 15.3) from these queries is larger by a factor of 2.09, which is similar to the overall factor of 2.05 found by Schwarz & Kennicutt (2004, their Table 6). This broad agreement suggests that the ADS can by itself generate useful statistics on the adoption rate and citation impact of astro-ph.

For papers published in 2002, I repeated the procedure described above for 13 different journals spanning the globe and covering a broad range of ISI impact factors. For three major astronomy journals (ApJ, MNRAS, and A&A) I also tracked the annual rise in the adoption rate of astro-ph from 1992 to 2004, to look for differences in the preprint posting habits of these author communities.

3 Results & Discussion

The rise in the use of astro-ph over the past decade has led to a major shift in the way astronomical research is disseminated, and it has had a dramatic impact on the citation rates of posted papers as a consequence. In Figure 1, I show the fraction of papers posted to astro-ph for three major astronomy journals from 1992 (astro-ph began in April of that year) to 2004. For all three journals, the adoption rate of astro-ph grew steadily into the late 1990’s and then started to level off over the past few years. Authors of papers appearing in the ApJ and MNRAS have adopted astro-ph at roughly the same rate over this time period, while authors publishing in A&A have generally been slower to adopt it. Current adoption rates for MNRAS and the ApJ have leveled off near 70-80\%. As noted by Schwarz & Kennicutt, this is similar to the fraction of authors who allow their articles to be posted in preprint form on the ApJ website (without any additional work by the author). This service was initiated by the ApJ in 2002, and may have actually contributed to the limited growth in astro-ph submissions in recent years by authors who considered it equivalent to astro-ph (MNRAS did not start a similar service until 2004). The adoption rate of astro-ph among A&A authors has grown more slowly and currently stands near 60\%, a value the ApJ and MNRAS both reached in 2000. Within the next 5 years, the use of astro-ph seems likely to become almost universal among authors of papers in these major astronomy journals.

A broad survey of the adoption rate and citation impact of astro-ph on papers published in 2002 for a wide variety of journals is summarized in Table 1. The survey includes high-impact multidisciplinary journals like *Nature* and *Science*, as well as a selection of astronomy journals published in various parts of the world with a wide range of impact factors. The topical journals *Solar Physics* and *Icarus* were included to try to elucidate the low adoption rate found by Schwarz & Kennicutt.
for ApJ papers in the subfield that included solar astrophysics and planetary science. The most striking feature of Table 1 is that in almost every journal surveyed, papers posted to astro-ph are cited significantly more often than papers that are not posted. For most of the major astronomy journals, astro-ph papers are cited between 1.6 and 3.5 times as often as non-astro-ph papers. The median boost is about a factor of 2, which is comparable to what was found by Schwarz & Kennicutt for ApJ papers.

Astronomy papers published in the high-impact journals get an even larger boost from being posted to astro-ph. Despite a significantly lower adoption rate, astronomy papers appearing in Nature and Science that are also posted to astro-ph are cited about 5 times more often than papers that are not posted. This extra boost may come from a kind of “brand recognition” associated with these high-impact journals, capturing an even broader audience than an astro-ph paper published in one of the other journals. High-impact journal papers that are not posted to astro-ph have citation rates comparable to non-posted ApJ papers, and are actually cited less often than major astronomy journal papers that are posted to astro-ph. Similarly, astro-ph papers that appear in journals with the lowest impact factors still get a citation boost over non-astro-ph papers near the average. As expected, the absolute citation rate is roughly correlated with the ISI impact factor, but the boost in citations due to astro-ph does not change by much across a wide selection of astronomy journals.

The only papers in this survey that did not receive a significant boost from being posted to astro-ph were those published in Solar Physics (SoPh). Schwarz & Kennicutt noted that the ApJ papers with the lowest adoption rate of astro-ph were in the solar system (SS) subfield, which included solar astrophysics and planetary science. The low adoption rate by itself may not explain the lack of a citation impact for SoPh since the adoption rate is even lower for Icarus papers, which are still cited twice as often when posted to astro-ph. An alternative explanation is that relatively few solar astrophysicists learn about new research through astro-ph. It is simply not yet part of the culture in this subfield.

4 Conclusions

Across a wide selection of major astronomy journals, papers that are posted to astro-ph are cited about twice as often as papers that are not posted. As the single source containing most of the new research to be published in refereed journals around the world, the astro-ph preprint server appears to be the method that most astronomers now use to keep up with the literature. If citation rates are any indication of the assimilation of new research by the astronomical community, then astro-ph seems to be the best single form of advertising available. Editors who want to maximize the impact factor of their journals should encourage authors to post their preprints to astro-ph, and authors in subfields where astro-ph has not yet been adopted should consider the advantages that other subfields have already discovered.

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