# How long should an astronomical paper be to increase its Impact?

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#### ABSTRACT

Naively, one would expect longer papers to have larger impact (i.e., to be cited more). I tested this expectation by selecting all ( $\sim 30,000$ ) refereed papers from A&A, AJ, ApJ and MNRAS published between 2000 and 2004. These particular years were chosen so papers analyzed would not be too "fresh", but at the same time length of each article could be obtained via ADS. I find that indeed longer papers published in these four major astronomy journals are on average cited more, with a median number of citations increasing from 6 for articles 2–3 pages long to about 50 for articles  $\sim 50$  pages long. I do however observe a significant "Letters effect", i.e. ApJ and A&A articles 4 pages long are cited more than articles 5–10 pages long. Also, the very few longest (> 80 pages) papers are actually cited less than somewhat shorter papers. For individual journals, median citations per paper increase from 11 for  $\sim 9,300$  A&A papers to 14 for  $\sim 5,300$  MNRAS papers, 16 for  $\sim 2,550$  AJ papers, and 20 for  $\sim 12,850$  ApJ papers (including ApJ Letters and Supplement). I conclude with some semi-humorous career advice, directed especially at first-year graduate students.

### 1. Introduction

There have been a number of publications analyzing patterns in citations in the astronomical literature, such as "Productivity and impact of astronomical facilities: Three years of publications and citation rates" (Trimble & Ceja 2008), "The Importance of Being First: Position Dependent Citation Rates on arXiv:astro-ph" (Dietrich 2007), "Demographic and Citation Trends in Astrophysical Journal Papers and Preprint" (Schwarz & Kennicutt 2004) or "Patterns in Citations of Papers by American Astronomers" (Trimble 1993), just to mention a few. Scanning abstracts of these publications, some career advice emerges:

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- 1. "There are hot topics (cosmology, exoplanets) and not so hot topics (binary stars, planetary nebulae)" and "service to the community, in the form of catalogues and mission descriptions, is rewarded, at least in citation numbers, if not always in other ways." (Trimble & Ceja 2008)
- 2. "We find that e-prints appearing at or near the top of the astro-ph mailings receive significantly more citations than those further down the list. This difference is significant at the 7 sigma level and on average amounts to two times more citations for papers at the top than those further down the listing." (Dietrich 2007)
- 3. "Papers posted on astro-ph are cited more than twice as often as those that are not posted on astro-ph." (Schwarz & Kennicutt 2004)
- 4. "It still pays to be mature, prizewinning theorist, working on cosmology or high-energy astrophysics at a prestigious institution." (Trimble 1993)

Some of that advice might be easier to implement than other, and sometimes a finely timed, Wednesday afternoon 04:00:03 p.m. EST submission to astro-ph produces less than desired effect (e.g., Stanek 2003, private communication).

However, to my knowledge, there has been no discussion of how long a paper should be to maximize its impact. Is it better to write several shorter papers or one longer paper? And serving as a referee, one of the standard questions is "Can this paper be made shorter?" But maybe it should be made longer? We have all heard a famous quote, often attributed to Mark Twain: "If I Had More Time I Would Write a Shorter Letter," but actually from Blaise Pascal: "Je n'ai fait celle-ci plus longue que parce que n'ai pas eu le loisir de la faire plus courte." Is not at all clear this is a valid advice when writing astronomical papers.

To alleviate that glaring omission, I have decided to investigate the citation vs. paper length correlation for astronomical papers. In Section 2 I describe the data, namely citation and page length statistics for about 30,000 refereed astronomical papers published between 2000 and 2004 in ApJ, A&A, AJ and MNRAS. In Section 3 I discuss the results, and in Section 4 I conclude with some career advice, especially useful for first-year graduate students in astronomy.

#### 2. Data

I used the ADS Abstract Service site<sup>2</sup> to obtain the page length and citations for all papers published between 2000 and 2004 (i.e., five complete years) in the four largest astronomical journals, A&A, AJ, ApJ and MNRAS.<sup>3</sup> I start in 2000 so that page lengths will be reported for all papers and end with 2004 to allow time for papers to mature (or not) and obtain citations. The journals were chosen so there would be plenty of papers for statistics, with the page length being about the same for each journal. There were 12,858 ApJ (including ApJL and ApJS) papers, 9,275 A&A papers, 5,330 MNRAS papers and 2,564 AJ papers, for a total of 30,027 papers. Originally, that number was somewhat larger, but I have removed all one-page papers from the list, as these were mostly errata or editorials, usually cited 0 times (although one such erratum has been cited almost 100 times). I should note that I procured these somewhat time consuming ADS data in mid-June 2008, so individual citation numbers might have increased a bit since then, but the overall trends should remain the same.

In Figures 1 and 2 I show the basic properties of our sample, such as the distribution of page length (Fig. 1) and distribution of citations (Fig. 2). While the distributions in presented in Fig. 1 are more or less the same, except for the expected A&A and ApJ Letters spike at  $N_p = 4$ , distributions presented in Fig. 2 are not identical in shape.

While the median number of citations per paper for the entire sample of  $\sim 30,000$  papers is 15, I note that  $\sim 3,150$  papers in the sample have 3 or fewer citations, while  $\sim 1,100$  papers have 100 or more citations, and only  $\sim 100$  papers have 300 or more citations.

#### 3. Results

Having both the number of journal pages and the number of citations, I can produce a Citation-Number (of pages) Diagram (hereafter: CND), which I present in Fig. 3. For display purposes, I have added +1 to the number of citations for each paper ("an honorary citation"), to avoid the  $\log citations = -\infty$  problem ( $\log citations = +\infty$  is not yet a problem, even for WMAP papers). Also, for display purposes, I add a random variable uniformly distributed between 0 and 0.9 to both  $N_p$  and number of citations, otherwise all papers with the same number of pages and citations would produce only one dot in the plot (since this paper is mostly directed towards first-year graduate students, this is a very useful trick when you

<sup>&</sup>lt;sup>2</sup>http://adsabs.harvard.edu/abstract\_service.html

<sup>&</sup>lt;sup>3</sup>These data are available by request from the Author

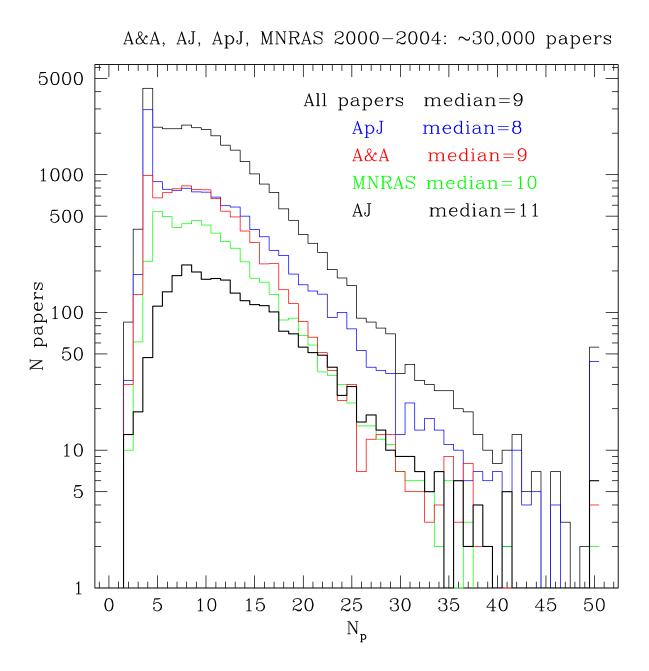


Fig. 1.— Distribution of page length for 30,027 A&A, AJ, ApJ, and MNRAS papers published between 2000–2004. A significant Letters spike can be seen at  $N_p=4$ .

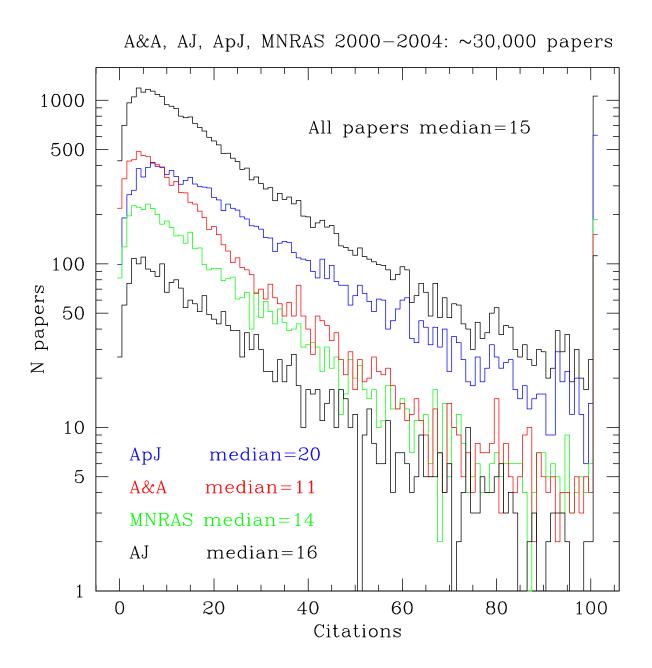


Fig. 2.— Distribution of citations for 30,027 A&A, AJ, ApJ and MNRAS papers published between 2000–2004, shown for the entire sample and for each journal separately. The median number of citations for the entire sample is 15, ranging from 11 for A&A to 20 for ApJ.

have to plot data where either the data are truly discrete or for whatever reason not enough significant digits were preserved).

The main cloud of points in the resulting CND (Fig. 3) looks like the state of Ohio (USA),<sup>4</sup> with very short papers with some citations located in Indiana, papers with none or very few citations located in Kentucky (short) and West Virginia (long), papers with very many citations located in Michigan (short), Lake Erie and Canada, and very long papers located in Pennsylvania. Readers can amuse themselves by locating their various articles on the CND and mentioning casually at their Coffee "I have three papers in Canada", "my paper just fell into the Lake Erie" or "my paper has finally moved from Coshocton County to Tuscarawas County."

For bins of journals articles with a given length, the median number of citations is shown by large open circles. These medians range from 6 for articles 2–3 pages long to about 50 for articles  $\sim 50$  pages long. There is a local maximum corresponding to papers 4 pages long, which I will show below is due to A&A and ApJ Letters. Also, the very few longest (> 80 pages) papers are actually cited less than somewhat shorter papers, although there are few such very long papers. One obvious thing to notice is that, as expected, for any given length of the paper there is a very wide range in the number of citations.

Impact per journal page (Fig. 4) is fairly flat at  $\sim 1.5$  citations/page for papers longer than 6 pages and shorter than 50 pages, but it peaks at  $\sim 4$  citations/page for papers 4 pages long and drops rather steeply for the longest papers. In the entire sample of  $\sim 30,000$  papers there are only 10 papers exceeding the rate of 100 citations/page and 54 papers exceeding the rate of 50 citations/page.

Seeing the morphology of the overall CND, I then decided to produce individual CNDs for each of the four journals, shown in Fig. 5. ApJ data are shown in the upper-right corner of Fig. 5, and the dashed line corresponding to bin medians for ApJ is then also shown in the panels for the three other journals. Both ApJ and A&A show a local maximum at  $N_p = 4$ , most likely due to Letters, while no such local maximum is present for AJ or MNRAS papers.

#### 4. Semi-humorous Career Advice

For non-humorous career advice in astronomy, see, e.g., "So you want to be a professional astronomer!" (Forbes 2008) or "The Production Rate and Employment of Ph.D. Astronomers" (Metcalfe 2008). Here is my semi-humorous publishing advice, directed es-

<sup>4</sup>http://www.smart-traveler.info/sitebuildercontent/sitebuilderpictures/map\_of\_ohio.gif

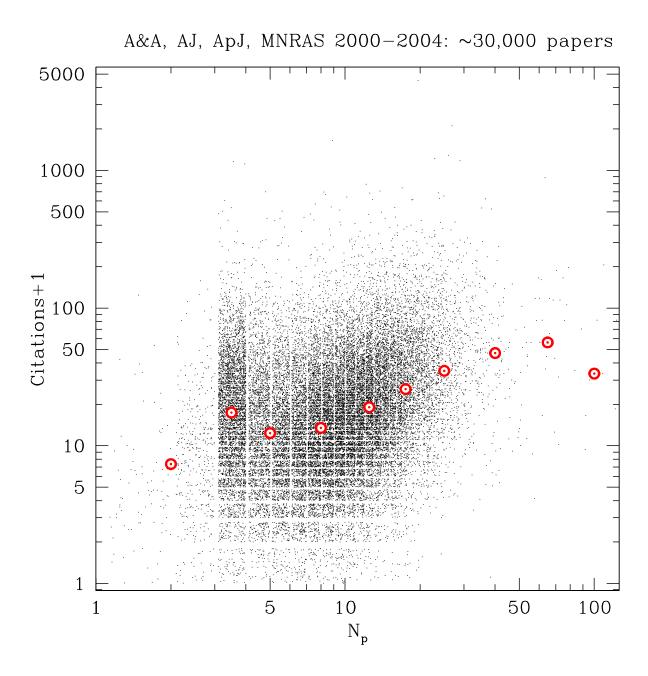


Fig. 3.— Citations vs. number of pages for our sample of 30,227 papers published in A&A, AJ, ApJ, and MNRAS between 2000–2004. For bins of articles with a given length, the median number of citations is shown with the large dotted circle, ranging from 6 citations for articles 2–3 pages long to  $\sim 50$  median citations for articles  $\sim 50$  pages long.

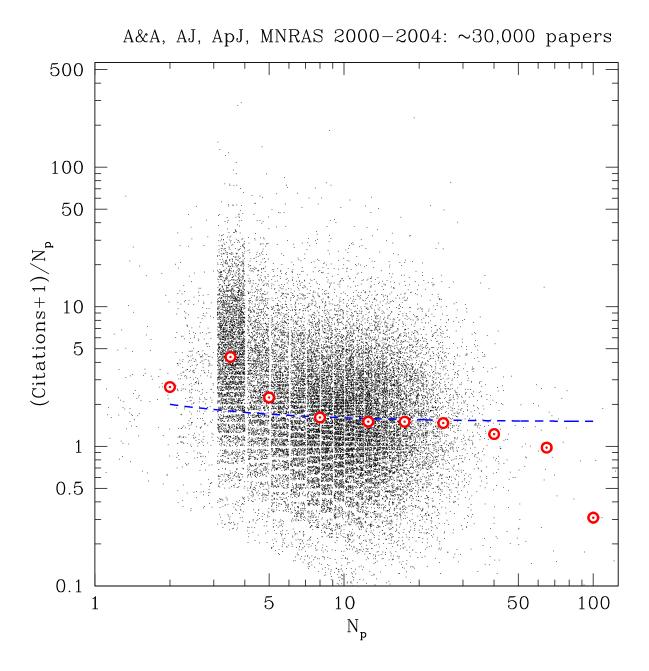


Fig. 4.— As in Fig. 3, but plotting citations/per page vs. the number of pages for our sample. For bins of articles with a given length, the median number of citations per journal page is shown with the large dotted circle. The dashed line shows a citation rate of 1.5 true citations/page, where the slope is due to the addition of one "honorary citation" to each paper.

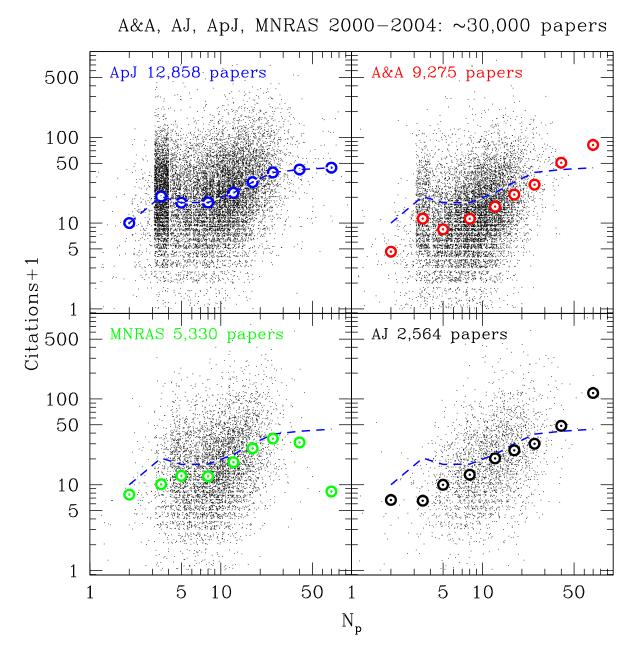


Fig. 5.— As in Fig. 3, but now shown separately for each journal. Dashed line corresponding to medians in each ApJ length bin is shown in each panel for comparison with the other journals.

pecially towards first-year graduate students<sup>5</sup> (this advice results from the current study combined with conclusions presented in other studies cited here):

- Initially, write and post to astro-ph as many first-author papers as possible and do not yet worry (too much) about their length or citations. As philosophers have asked since the time of ancient Greeks and maybe even before, "If you did the research and did not post it on astro-ph, did it really happen?" At this point in your career first author papers are crucially important for you, due to the prevailing system of attributing credit in astronomy and the way papers are referred to using the name of the first author (name recognition). Make sure you submit your papers to astro-ph archive just after 4 p.m. US Eastern time<sup>6</sup> on Wednesday (and avoid, if you can, posting your paper such that it appears on Tuesday)—this way your papers will on average be cited about 3 times more than papers only published in journals (Dietrich 2007; Schwarz & Kennicutt 2004).
- Also early in your career, it makes sense to write and post on astro-ph your conference contributions, as they increase your name recognition, but longer term, conference proceedings papers are cited 20 times less often than the average ApJ paper (Schwarz & Kennicutt 2004), and in fact median number of citations to a conference contribution is either 0 or 1.
- Later in your career you will worry more about your total number of citations, but you will also discover that you somehow need to find money to pay for the journal page charges. This is when you want to increase the fraction of Letters in your publication portfolio, which increases the number of citations per unit of currency.<sup>7</sup>
- At a still later point in your career you will find out about the h-index (Hirsch 2005) and you will become obsessed with it, possibly listing its value on your CV and/or website and telling other astronomers that your h is bigger than their h. You will therefore want to start writing longer papers, as these will be more likely to have more

<sup>&</sup>lt;sup>5</sup>There is no guarantee that any of this advice will be helpful in your career; it is provided as a public service and a source of possible amusement. No warranty is expressed or implied. The Ohio State University disavows any responsibility for the information contained herein.

<sup>&</sup>lt;sup>6</sup>http://arxiv.org/localtime

<sup>&</sup>lt;sup>7</sup>Monthly Notices of the Royal Astronomical Society has no page charges, except for colour in the printed version. A&A has page charges at the rate of 100 euros per printed page, but charges are not requested if the first author is affiliated with one of the countries that sponsor A&A. AJ and ApJ charge between \$105 and \$195 (paper submission) per page, or you can just send them 20 euros in cash.

citations overall, increasing your value of h-index. At this point of your career you do not have to worry as much as before about being the first author on your papers, but you will probably have to find money to pay for the page charges for your first-author junior collaborators, who face a different optimization problem.

I thank the late Professor Bohdan Paczyński for his valuable advice and insight over the years, including always valid "Many astronomers confuse difficult with interesting", which partially inspired this paper. I would like to thank the participants of the morning "Astronomy Coffee" at the Department of Astronomy, The Ohio State University, for the daily and lively astro-ph discussion, one of which finally prompted me to produce this posting. However, they do not deserve any blame in the unlikely case you lack a sense of humor. I thank Chris Kochanek and Molly Peeples for their useful comments on an earlier version of this paper. The data and plots presented in this paper are real, despite the (mostly intended) humorous style of writing. This paper will not be submitted to any journal, but please feel free to cite it as often as possible, or better yet cite my regular astronomical papers.

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