The Astronomical Literature

What is "the literature"? Why does it matter?

You may hear someone claim to have done a "literature search", or be told to "go look it up in the literature." Just what is this "literature"?

Scientists have been writing reports on their activities for centuries. The scientific literature is simply the entire body of written material which has been preserved over the years. One of the strengths of the scientific method is that it builds upon the knowledge gained through previous experiments. The "literature" is not only a record of what's been done -- it is also the basis for future progress.

Compare this situation with that in some other field; say, the art of painting. There is certainly a great body of literature describing the history of painting, and students are encouraged to study the work of the past as they are learning their craft. However, a young painter in the twenty-first century might reasonably become successful -- sell his work for high prices, hold exhibits in prestigious galleries, etc. -- without any training in art history or period of apprenticeship. Sure, it's unlikely, but there are precedents for young artists with their own distinctive styles suddenly making it to the top. Moreover, it's not necessary for a painter to understand the techniques of French artists of the late eighteenth century in order to create his own works -- he might choose a genre (cubism, or abstract) which is completely unrelated to theirs.

A scientist in the twenty-first century must understand the phenomena discovered painstakingly by his predecessors in order to become a success. No matter how smart a young astronomer may be, and no matter how innovative his mind, if he doesn't learn about (for example) gravity, electromagnetism, and the atomic nature of matter, he isn't going to become a success. It's simply not possible for a single human to re-discover, independently in a single lifetime, all the myriad rules governing the behavior of bodies in the universe ... and then go on to push the boundaries further forward.

One can also look at it in a different light: a scientist who applies for funding to do an experiment which has already been done a hundred times will not get the money.

Refereed journals

Over the years, groups of people with common jobs and goals have formed professional associations: the American Medical Association, the New York State Bar Association, the American Society of Mechanical Engineers, and so on. One purpose of these associations is simply to provide members of the public with confidence that some particular person has a certain set of skills in some area.

Suppose some unscrupulous villain decides to make a quick buck by performing surgery at discounted rates -- still high enough to pad his bank account, of course. He could set up an office and advertise:

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Joe Sawbones, Discount Surgeon
 Operations done While-U-Wait
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He might fool a lot of people into giving him their cash in exchange for botched operations. That would be bad for real doctors, of course: their reputations would suffer, if the public couldn't tell them apart from such a charlatan. Therefore, doctors have formed exclusive societies. In order to join, one must perform a number of tasks to demonstrate that one really is a doctor. (Well, that's the theory; it's still possible for dedicated frauds to slip into professional societies, but the great majority of bozos give up and move on to easier rackets.) A citizen in need of medical care can simply check that a particular doctor is a member in good standing of the AMA, and then go to that doctor with confidence.

The same is true in astronomy: scientists have formed a number of professional societies, both to enhance their standing in the public's mind, and as an aid in organizing themselves for efforts towards common goals. Some of these societies publish journals; just to name a few,

The Astronomical Journal, published by the American Astronomical Society Publications of the Astronomical Society of the Pacific, published by the Astronomical Society of the Pacific Astronomy and Astrophysics , which was formed by the union of journals from a number of European astronomical societies These journals are refereed: they do not automatically accept and publish all submissions. Instead, the journal's editor sends each manuscript to one or more "referees", who read it thoroughly and judge its merits. Here are the instructions I received recently when asked to referee a paper for PASP.

> *Any comments you have will be greatly appreciated. Please specify whether your suggestions should be considered mandatory for publication. It will be helpful if your report includes the following, when appropriate:*
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> 1. *Does the article contain sufficient new results or ideas, and does it reflect sufficiently high scientific standards to warrant its publication in the PASP (i.e. similar to other major astronomical journals)? In particular, is there sufficient interpretation or analysis of any data presented?*
> 2. *Is the paper written concisely enough while still compatible with accuracy and clarity? Could the order, presentation, or English be improved? Do you have comments or criticisms that may help the author(s) improve or correct the presentation?*
>
> *In order to provide timely publication of articles, could you send us your report within 2-3 weeks of receiving the manuscript? If possible, please use e-mail (pasp@asu.edu). Clearly indicate any parts of your report that should be withheld*

from the authors(s).

The referee writes a report on the merits of the paper and sends it to the editor. The editor may then publish the paper, reject the paper, or (usually) send the report to the author of the manuscript and request that he address the concerns in the report. If the author chooses to submit a revised version, the editor may publish it, if he judges it to have fixed the items mentioned in the referee's report, or send the revised version to the referee for a second round of checking. In a few cases, the paper may go through many rounds of refereeing before finally being accepted or rejected.

The bottom line is that peer review acts as "Quality Control" for the journal. It prevents obviously wrong material from being published, and helps to improve legitimate papers. The refereeing system isn't perfect, by any means, but it does greatly improve the Signal-to-Noise ratio in scientific journals.

There are drawbacks to peer review:

- it adds months (or at least weeks) to the time required to process and publish a paper
- it increases the cost of publishing a journal. Most scientific journals don't accept advertising (and most wouldn't get any advertisements, even if they did), so subscriptions are very expensive. A person who is not a member of the American Astronomical Society, for example, must pay $1,770 per year for electronic access to the Astrophysical Journal, and an additional $860 for a paper copy. Even members must pay $410 per year for a combined electronic and paper subscription.
- it demands that scientists donate a small amount of their time to review papers anonymous referees can abuse their power without fear of recrimination Still, given my experience with unmoderated newsgroups on the Internet over the past twenty years, I'd choose some system of peer review over no review, every time.

The preprint archive system

Actually, the past decade has seen the growth of a very important means of "publishing" scientific papers without peer review. For years, scientists have sent copies of their manuscripts to friends and colleagues before publication. Some authors wait until their papers have been approved by the referees ("accepted for publication ..."); other brave authors distribute copies at the same time that they first send the work to the journals ("submitted for publication ..."). The idea is to show one's progress to others without having to wait for the 4-12 months it usually takes for a paper to make its way into print. These pre-publication copies are called preprints.

In 1991, a physicist named Paul Ginsparg decided to improve the efficiency of preprints by setting up a computer system to replace the postal service. Scientists could submit preprints to the computer electronically, and also browse through the submitted articles over the Internet. The system, now hosted at arXiv.org , became an overnight success. Ginsparg split up the

papers into categories, one of which is dedicated to astronomical papers:

http://arXiv.org/archive/astro-ph

Strangely enough, despite the lack of any peer review on the system, it remains to this day largely free of crackpots.

Exercise 1: Use astro-ph to find a recently submitted paper describing Kepler observations a self-lensing binary star system. What is the name of this star system? What is its period?

Searching the literature

Back in the old days (even before my time), searching for papers describing some particular object was a major hassle. One had to page through thick tomes called Astronomy and Astrophysics Abstracts, the look up each reference in old journals on the shelf (if your library had them); all to discover, most of the time, that the paper wasn't relevant to your needs. Ugh.

Fortunately, you are living in the age of computers, in which all your dreams come true as long as you have a high-speed Internet connection. You can almost always find what you want by remembering just three sites.

The ADS Abstract Service.

This is by far the most useful tool for finding astronomical papers on some topic, or by some author. Simply go to the ADS site,

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

fill in the appropriate information in the search form, and click on "Submit." In seconds, you'll receive a list of (usually) hundreds of papers. You can quickly browse the titles to pick likely candidates, then, with a single click, read the abstract to make sure that the paper meets your needs. If it does, you can (usually) read it on the screen, or print out a copy.

Exercise 2: Dr. Morehead was one of many authors on the discovery paper for the Kepler-11 exoplanet system. Who was the lead (first) author and what number author was he in the author list?

Astro-ph

The astro-ph preprint server contains new papers which might not yet have been published, as well as some material which is NEVER published. You can go to the astro-ph search form,

http://xxx.lanl.gov/find/astro-ph

to make a search through the archives.

Exercise 3: Has anyone discovered a transit by an earth-like planet around another star?

Try using Abstract Keywords extrasolar planetary transit earth and searching for recent papers.

CDS

Centre de Donnees astronomiques de Strasbourg (CDS) is a data center dedicated to the collection and worldwide distribution of astronomical data and related information. It is located at the Strasbourg Astronomical Observatory, France. In addition to hosting SIMBAD and Aladin , the CDS holds a large archive of astronomical catalogs. You can search through them with the Vizier tool.

http://cdsweb.u-strasbg.fr/

Exercise 4: What sort of data is contained in the Henry Draper catalog? When was this catalog first published? How many objects are in it?

Search Engines

You won't find every astronomical result via these search engines, but they are good places to start.

Exercise 5: Find Arlo Landolt's paper on standard stars near the celestial equator published in 1983 (he published another one in 1992). How many pages does the main table of stellar magnitudes cover?

Bonus (+5% to this lab): Find a copy of Landolt's standard star magnitudes in electronic form. Save it to disk. Make a graph showing the position of these stars in the sky, with RA on the x-axis and Dec on the y-axis.

How to read a scientific paper

It is possible to read a scientific paper from start to finish. Most of the time, however, you want to extract some particular information from the paper, and you don't want to spend a great deal of time doing it. You will probably find your own method for scanning articles, but here's mine, for what it's worth.

Read the title. Is it close to my topic? If not, quit. Read the abstract. Will the paper contain the information I want? If not, quit. Flip through the article, looking at the figures and, for those which seem relevant, read the captions. I can often find what I want in the figures, or in the text nearby. Read the conclusions. The author ought to give a quick summary of the quantitative results. Flip through the main body of the paper, looking for the section devoted to your particular interest. For me, that's usually the section labelled Observations or Data Reduction. When all else fails ... read the entire text.

One danger of skimming a paper is that you might find the number for which you're looking, copy it down, and discard the paper. If the number is really important to you, you have the

obligation to make sure it's correct. There are times when you really must read every word of a paper in order to find the crucial point at which the analysis takes a wrong turn, or some assumption is made. Remember: just because a paper survived the peer review process doesn't automatically make it correct.

Additional exercises

Exercise 6: There is a relation for star formation known as the Schmidt Law. Find the original paper and the three most recent papers to have cited this paper and record the reference information for these papers.

Exercise 7: List the three most recent refereed papers that discuss Abell 1689.

Exercise 8: What is the most cited paper in astronomy from 2015? How many refereed papers were published in 2015?