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Exponential Growth of Scientific Information and Orientation in World Wide Web

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Abstract. A swift growth in the number and length of publications in the narrow, but advanced field of astronomy, is shown with certain research examples. There are too many astronomical sites on the Internet, but ADS, CADC, SIMBAD and HEASARC are actually indispensable for one's daily scientific work. The necessity of the project, that links all astronomical information resources, is noticed. Cooperation between an astronomer and a librarian is also important for working efficiently. The situation with Internet resources in Ukraine is briefly described.

1. Introduction

It seems that writing astronomical papers is easy. On the Internet, one only needs to collect data and other relevant information, combine it and the paper is ready.

In 1998, H. Abt, who worked as an editor of the *Astrophysical Journal* noted, "The average number of papers increased exponentially by nine percent before mid-1970s and by four percent per year thereafter". The rate was decreased after mid-1970s, but that is the exponential growth of a gigantic volume of stored information!

I can give an example from my own experience: We investigated variable star δ Scuti type VW Ari (9075 references in ADS from 1980 to 2002 for δ Scuti stars). During our search, it became clear that the star has the same features of λ Bootis type stars (7634 references in ADS for the same period). Subsequently, we suspected that the star may also be an ellipsoidal binary (28908 references in ADS for the same period). Of course, it is not necessary to read all the papers; however, even one percent of this information is large. That is the situation in the modern science. On the one hand, every astronomical field has its own special table of symbols, conventions and mathematical tools; while on the other hand, depending on the investigative field, scientific activity modifies their unique language according to its needs.

The length of scientific papers increased sharply after the Second World War (Trimble 1986) and continues to rise. From 1960 to 1996 (Abt 1998), the average growth in page numbers, for five basic journals, has increased by a factor of 16.8.

2. Internet Crisis in Ukraine

Some current internet problems that exist in the Ukraine include: high cost for usage, a connection speed that is usually not higher than 33 kbit/s, and lack of access to licensed and paid information. In fact, online access is limited to a few minutes per day. Only main astronomical observatories, such as the National Academy of Sciences of Ukraine (http://www.mao.kiev.ua), have unlimited access. Even the famous Crimean Astrophysical Observatory (http://www.crao.crimea.ua), has poor Internet connections. Other observatories either have limited or partial access. At Odessa Observatory, we have one computer to serve a staff of 60 people! We are allowed a mere one hour of free connect time per day, and the remaining costs for usage are covered by our scanty salaries!

We hope that the situation will be changed in the near future, and as such, we are preparing our archives for public access. For example, at Odessa Observatory, we have a collection of more than one hundred thousand wide-field photographic patrol plates, that were obtained from 1920 to 1998. It is one of the biggest archives of patrol plates in the world. The electronic catalogue of our collection was published by Pikhun & Yushchenko (2002). Now it is accessed from the site of IBVS, (http://www.konkoly.hu/cgi-bin/) but not from the Odessa Observatory site.

Actually, the great potential of Ukrainian science has not yet been called for by the astronomical community.

3. Really Used Astronomical Sites

Given the circumstances,what is the most effective way for our scientists to acquire the information they need for effective research? We have often discussed the problems in order to acquire thrifty access to the Internet at Odessa. For instance, when I participated in the Thirteenth European Workshop on White Dwarfs, that was held in Naples (from the 24th-28th June 2002), leading investigators offered interesting and varied preferences for variable star sites online. The answers were similar to those mentioned by astronomers I have spoken with in the Ukraine, and I have summarized their answers as follows:

3.1. ADS

The site held in highest regard was the NASA Astrophysics Data System (hereafter, ADS). Each one of us accesses ADS many times per day. The efficiency of the query results was estimated to be from 90% to 100%. The ADS is undoubtedly the most basic, well-constructed and well- organized system with easy and democratic access. The system is up-dated often and that makes it quite reliable, although some absence of data was noticed by Schulman et al. (1997). For further understanding about the system, read, "ADS Articles in Astronomy and Astrophysics Supplements" (http://ads.harvard.edu/pubs/A+AS/)

ADS's most preprint section is very popular. (http://arXiv.org/). Here, astronomers quickly locate preprints of interest. Oftentimes, there is a lively exchange of information and ideas, thus providing further incentives for scientific investigation. This site has special importance for Ukrainian scientists because

many institutions, over the past four or five years, have not been able to purchase any of the major journals.

3.2. SIMBAD

SIMBAD is used for data access, however, many affiliations are not free and the access is complicated. Schulman at al. (1997) showed that ADS has twice as many queries per month than SIMBAD. Some people also noticed that a large part of photometric data are not linked to SIMBAD; for example, the Geneva University site (obswww.unige.ch/gcpd/gcpd.html).

3.3. CADC

The CADC, Canadian Astronomy Data Centre is very much appreciated in Ukraine and Russia due to its free intellectual and competent access to many catalogs, archives and sites, including the International Astronomy Meetings List (Aloha, Liz Bryson!). Many Ukrainian scientists are Guest Users of CADC, that is operated by the Herzberg Institute of Astrophysics, National Research Council of Canada.

3.4. HEASARC

For high energy astrophysics, HEASARC is arranged very well. Users can find everything from space missions to detailed description of objects in the vicinity.

4. The Necessity of the Project that Links Together all Astronomical Information Resources

But there are not similar sites for other branches of astronomy. For initial or general information, we use Google or Yahoo and everybody knows the (in)efficiency with their results! It is possible to use AstroWeb or StarWeb but their information is rather restricted, not uniform and sometimes not reliably updated.

URANIA was apparently one of the projects "which links knit together the scholarly references, citations and data sources for user as never before, brining the whole web of distributed information resources to the reader desktop" (Boyce 1998). However, we no longer have access to URANIA.

It is possible that the Virtual Observatory project (see for example, Dluzhnevskaya et al. 2002) will enable us to receive all the information that is necessary for scientific discovery.

5. Role of Librarian-As-Guide in the Internet

Astronomers tend to use only a small number of traditional sites and often lack the time to pursue investigating more subject specific URLs. As such, qualified librarians have become valuable in sharing their Internet expertise with the scientific community. We can cite Corbin (1998), Stevens-Rayburn & Bouton (1998), Grothkopf (1998) and others who have really analyzed the situation on the Internet, assisted with astronomical investigations and were guides for many specific problems. It would be wonderful if every institution had their own "experts on Internet problems".

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