Astronomy & The Internet

by FRED HAPGOOD

In November 1996, the author toured the Harvard-Smithsonian Center for Astrophysics for OMNI Online. *The complete text at http://www.omnimag.com/live_science/astro.html touches on quasars, meteor strikes, robot telescopes, SETI, spectrum tourism, and the X-ray Hubble. This piece on the Internet and astronomy led the series.*

YET THERE ARE A FEW CORNERS where the degree of change has been as radical as any futurist could could hope for; where a profession has been torn up and remade practically overnight. Astronomy is one such case. Over this decade the digitization of astronomical data, the continuously falling prices of bandwidth, processing, and data storage, and a community-wide effort to hammer out data standards and write sophisticated analysis and data handling software, have all combined to create huge increases in connectivity among astronomers, their instruments, and their libraries. This new power has changed almost everything about the field.

For one, it has ruined astronomy's logo. Historically when directors of TV programs or journalists writing a story have wanted a scene that says "astronomer" they have gone to observatories: large, echoing, cold, red-dark, silent spaces (because observing has to be done at night, with only dim red lights on, in structures open to the sky, often at the top of mountains). Here the intrepid scientist could be found, wedged uncomfortably into the observing cage of a great telescope, sitting hour after hour while the world slept, in heroic pursuit of images from the edge of the Universe.

In the last five or so years this canonical image has vanished from practice, though no doubt it will linger on in TV science series for another decade. Today astronomers keep the same hours, work in the same environment, and go through the same motions as everyone else: they come to their office in the morning, sit down at a workstation, and surf the net.

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>
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When observations need to be made the researchers define the coordinates of the region in question and then email them to an observing facility. The request goes into a stack; eventually, depending on details like the popularity of that particular instrument and the scale of the request, the observations will be made and the results returned, also by email. "The astronomer used to go to the data; now the data go to the astronomer" is how CFA scientist Stephen Murray sums up the change.

This new connectivity also allows astronomers to find and retrieve historical observations from research libraries all over the world in minutes, without traveling to those institutes or waiting for film to arrive by mail. With a bit of searching, a scientist can retrieve and inspect almost all the observations ever made of an object. This increase in access means that more and more useful research can be conducted from archives instead of new observations, which are expensive and take time to complete. (Murray says now half the publications in his field are based on archival research as opposed to new observations.)

Pulling observations out of the archives not only saves time and money; archives have the further advantage that they are indifferent to frequencies. Type in "Sirius" and you can get all the observations made of that object, across 15 magnitudes of wavelength, from the longest radio waves to the brightest gamma rays. By contrast, a given physical observing instrument never sees beyond a small slice of the spectrum. Over the last 50 years this specificity balkanized the profession by spectral region, into X-ray astronomers, radio astronomers, and so on. A database is blind to these distinctions: once the right observations have been made, a researcher can pull the entire profile of an object up on the display. He or she can can see it complete and entire. This new perspective has begun to bring the profession back together, to make it whole as well. "We're all just astronomers now," Murray says.

Professional facilities like the Center of Astrophysics have changed as well, from being exclusively concerned with the building and operation of telescopes to organizing and running the equivalent of a WAN for astronomers, clearing (in the case of the CFA) 25,000 email messages a day from researchers looking for data or requiring assistance of some sort. The Center runs a half dozen data services, each organized around separate missions or instruments (such as organizing the data sent from different satellites), encyclopedic data archives, online bibliographic databases, libraries of programs used to manipulate data, and banks of support personal for astronomers using those programs or needing access to the data. The website of one the larger of these data services, the Astrophysics Data System (adswww.harvard.edu) got 1.7 million hits in October 1996.

This new connectivity has obvious implications for amateur astronomy and astronomy education. As mentioned above, professional astronomers can order observations from any facility in the world (in theory). No one would think of requiring a professional astronomer to build his own facility before conducting his research. Amateurs have not had this freedom: an amateur astronomer has had to build or buy his own instrument or do without. Since good instruments are expensive and since most people live in areas where the viewing conditions are poor, most of us who were interested in the stars as children have had to let that interest die.

Steve Leiker of the CFA is working on an NSF-funded project that will bring the flexibility of a professional viewing to amateurs. He and his colleages at the CFA have built five small but serious unmanned optical telescopes (5.5-inch reflectors), all competent to be placed on a rooftop somewhere and then operated through the internet. They will work the same way contemporary professional telescopes do, automatically accepting observing requests, carrying them out, and then sending the results back over the net.

While the NSF project contemplates purely educational functions for these instruments, Leiker is well aware of another market: amateurs willing to pay a few dollars an hour for a few hours a week of observing time. Assuming the instrument is sited in a region permitting 1000 hours of viewing time a year (out of

a total of 8746 hrs/yr), a $10/hour fee would return the purchase price of a $20,000 instrument in two years. One can imagine a range of instruments available at differing sensitivities and prices: time on weaker telescopes might be a dollar an hour; stronger machines, $25/hr, and so on. If these economics work out, the range of observing opportunities open to enthusiasts would increase spectacularly.

Of course the same revolution in connectivity makes it simpler for amateurs to build up their own star atlases, to extract and coordinate material drawn from multiple archives, and publish those atlases on the net. Over time perhaps the most important effect of the new connectivity—in astronomy and elsewhere—will be to blur the line between the professional and lay science communities.

Favorite Astronomy Internet Sites

Observing and Research Data Sites

http://www.ucolick.org/~deep/home.html	DEEP Homepage
http://www-sdss.fnal.gov:8000/	SDSS (Fermilab)
http://tarkus.pha.jhu.edu/database/sdss.html	SDSS (Johns Hopkins)
http://tarkus.pha.jhu.edu/deep/deimos.html	DEIMOS
http://panisse.lbl.gov:80/public/	Supernova Cosmology Project Homepage
http://www.ifa.hawaii.edu/~cowie/hdf.html	Hubble Deep Field data

Global Resources Sites

http://www.nasa.gov/	NASA homepage
http://guinan.gsfc.nasa.gov/	High Energy Astrophysics Science Archive Research Center
http://www.stsci.edu/	Space Telescope Science Institute
http://oposite.stsci.edu/pubinfo/Latest.html	New HST photographs
http://oposite.stsci.edu/pubinfo/Pictures.html	HST Public Pictures
http://www.jpl.nasa.gov/	Jet Propulsion Laboratory
http://www.ucolick.org/	Lick Observatory Homepage
http://www.apo.nmsu.edu/	Apache Point Observatory
http://www.mtwilson.edu/	Mt. Wilson Observatory Tour
http://astro.caltech.edu/observatories/palomar/	Palomar Observatory
http://physics7.berkeley.edu/home.html	Center for Particle Astrophysics
http://www.fisk.edu/vl/astro/astro.html	Astronomy/Astrophysics Directory
http://www.aas.org/AAS-homepage.html	American Astronomical Society
http://www.aspsky.org/	Astronomical Society of the Pacific
http://www.journals.uchicago.edu/ApJ/	Astrophysical Journal
http://heasarc.gsfc.nasa.gov/0/docs/acronyms.html	Commonly Used Astrophysics Acronyms
http://www1.tmisnet.com/~abdale/Astronomy/Astronomy.html	What's Up This Month in Astronomy
http://bolero.gsfc.nasa.gov/~odenwald/ask/askmag.html	Ask the Space Scientist
http://www.windows.umich.edu/	Windows to the Universe
http://www.seds.org/	Students for the Exploration and Development of Space
http://bang.lanl.gov/solarsys/homepage.htm	Views of the Solar System
http://www.astro.princeton.edu/~frei/galaxy_catalog.html	The Galaxy Catalog
http://ngst.gsfc.nasa.gov/	Next Generation Space Telescope
http://engr.arizona.edu/~stetson/	Astronomical Tools
http://www.wpo.net/	Windowpane Observatory
http://www.skypub.com/	Sky & Telescope Magazine
http://www.astronomy.com/	Astronomy Magazine
http://www.fisk.edu/vl/astro/astroweb/yp telescope.html	History of Astronomy
http://jean-luc.ncsa.uiuc.edu/Exhibits/	Numerical Relativity Exhibitions

Literature Databases

http://adswww.harvard.edu/	NASA Astrophysics Data System
http://www.noao.edu/apj/ypages/last10.html#\apj	Papers Submitted to Selected Astronomical Publications
http://xxx.lanl.gov/archive/astro-ph	Astrophysics Preprints

Meetings

http://cadcwww.dao.nrc.ca/meetings/meetings_without.html	International Astronomy Meetings
http://yorty.sonoma.edu/people/faculty/tenn/BayAreaLectures.html	Colloquia in the San Francisco Bay Area