TREASURE HUNT IN THE SUN'S NEIGHBORHOOD

Based on a Contribution Solicited from Todd J. Henry (Georgia State)

Todd Henry (Georgia State), Phil Ianna (Virginia), and Rene Méndez (ESO) used the 0.9-m and 1.5-m telescopes at CTIO to discover five new star systems, one of them a triple, lying only 7 to 15 pc away. These seven stars are the first results from CTIOPI (Cerro Tololo Interamerican Observatory Parallax Investigation), a three-year project to determine parallaxes for stars lurking undiscovered in the solar neighborhood, carried out under the auspices of the NOAO Survey Programs. Each of the new discoveries provides a fresh target for planet hunters and, eventually, for astronomers searching for signatures of biological activity on those planets.

All of the new discoveries are M2 - M5 red dwarfs in the southern sky, where historically research on nearby stars has been less extensive than in the north. Although they are among the nearest few hundred star systems, these five have been overlooked due to their low luminosities.

The nearest of the new neighbors is LHS 3746, a small ember of a star only one-third the mass and diameter of the Sun, emitting less than 1% of the Sun's light. With a distance of only 7.6 pc (parallax of 0.1322 ± 0.0074 arcsec), it is the 113th nearest system. It is the newest member of the 10 pc RECONS sample established by Henry, which now includes 316 objects in 228 systems.

These new solar neighbors are merely the first wave of results from a large effort that will determine distances to 250 nearby star systems. During the three-year duration of CTIOPI, which was awarded four nights on the 0.9-m and two nights on the 1.5-m each month, nearby stars are identified as those tracing out serpentine paths on the sky relative to more distant stars. The length of the path is determined by the star's proper motion and its wiggle by its parallax. At present, there are more than 150 systems on the program at the 0.9-m (6.8′ field using the central 1K of the CCD) and nearly

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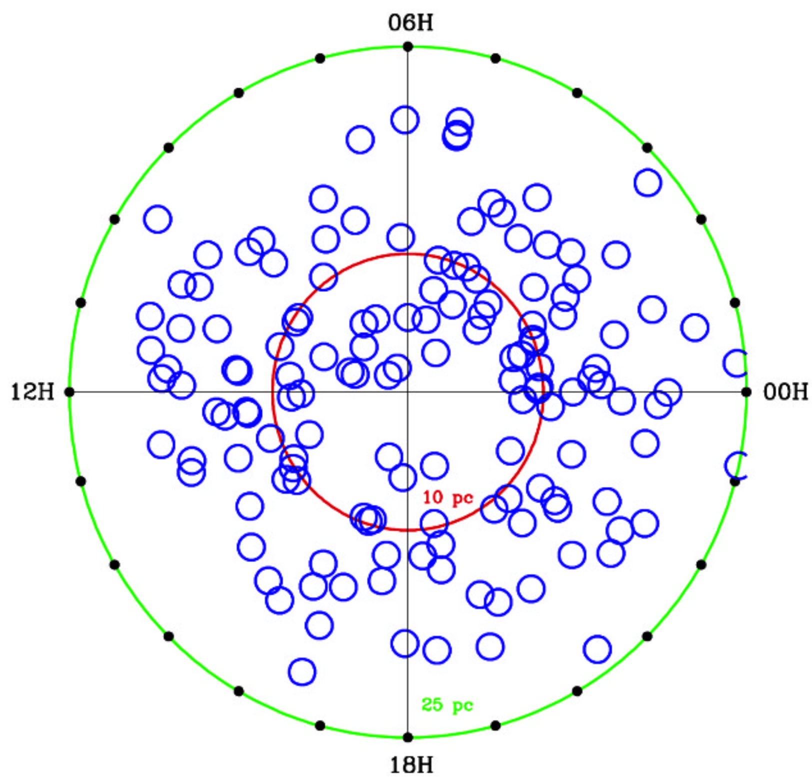

CTIOPI candidates for nearby solar companions are plotted as a function of right ascension and distance from the Sun. A total of 158 systems are on the program as of January 2001: 45 systems possibly within 10 pc, 99 systems possibly between 10 and 25 pc, 3 systems probably beyond 25 pc, and 11 systems with no distance estimates.

Treasure Hunt continued

100 more on the 1.5-m (8.2′ field using the entire CCD). Due to good weather, reliable telescopes, sensitive CCDs, and superb support at CTIO, CTIOPI is on track to exceed its goal of determining parallaxes better than 3 milliarcseconds (mas) for 150 systems. These first, albeit preliminary, parallaxes have errors of 2.3 to 7.4 mas using only 16 months of data (rather than the ultimate 36 months), and typically only half of the total number of frames anticipated (about 40) for 3 mas precision. Henry, Ianna, and Méndez are encouraged by the success rate for these first targets—five for five within 15 pc (let alone the goal of 25 pc) is an excellent start.

Target systems—white, red, and brown dwarfs with R magnitudes between 10 and 20—have been selected from a variety of sources. Proper motion candidates are chosen from the historic Luyten and Giclas surveys, for which 15% of systems with proper motions in excess of 1″/year have no parallaxes at all. In addition, several new proper motion surveys that illustrate the international flavor of nearby star work have provided new candidates, including several from Wroblewski et al. (Chile), Scholz et al. (Germany, United Kingdom), Méndez et al. (Chile, United States), and Ruíz et al. (Chile). Photometric candidates are chosen from the extensive published work of Weis (United States) and from the historical archives of Jahreiss (Germany), who has been generous in providing targets with unpublished data. Recently, several brown dwarf candidates (many of which are not yet published) have been provided by Delfosse of the DENIS team. There are also a few dozen targets

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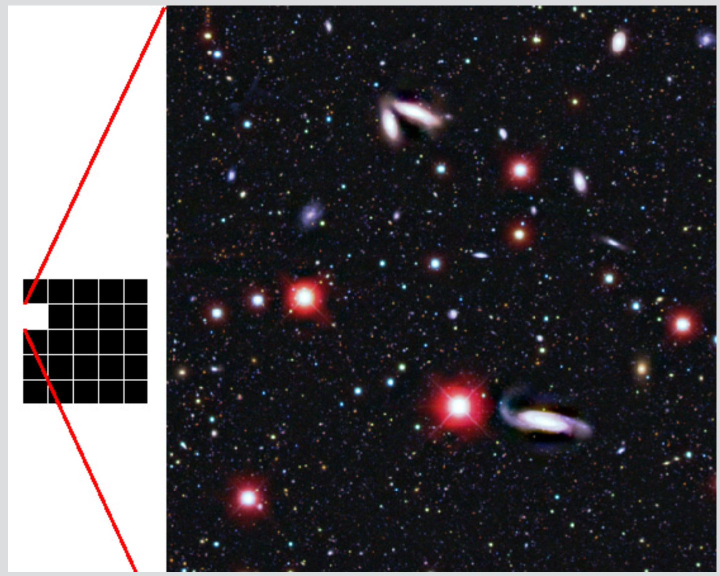
First Data Release from the NOAO Deep Wide-Field Survey



The NOAO Deep Wide-Field Survey is a deep optical and near-infrared imaging survey that will sample the sky in two 9-square-degree fields. The survey is designed to investigate the existence and evolution of large-scale structures at redshifts z>1 and study the evolution of galaxy populations out to redshifts of z~4. In addition, the survey will provide the astronomical community with a sensitive multicolor database from which samples may be selected for the study of a host of other interesting astronomical problems.

The Bw-, R-, and I-band images, which are roughly centered on J2000 14h 27m +35° 14′, are now available at *http://archive.noao.edu/ndwfs/*.

The first release of data from the NOAO Deep Wide-Field Survey, which covers a 1.2 degree square, is a sub-set of the 3° × 3° survey field at high galactic latitude (b=67°). Roughly 300,000 galaxies and stars are detected in the images, which have a 5σ detection limit in all bands close to 26th mag (AB).

Treasure Hunt continued

that are being observed intensely for perturbations caused by unseen companions, a classic astrometric experiment that has not been done for southern sky targets. When combined with data from Ianna's long-term Australia program, companions of brown dwarf mass with orbital periods of a decade might be revealed.

At present, there are roughly 2100 systems known closer than 25 pc, the distance limit of a sample of stars being studied in great detail by NASA's Nearby Stars (NStars) Project. CTIOPI hopes to increase that number by 10% or more. NStars is part of a long-term initiative to promote research on nearby stars from both the ground and space, including work on fundamental stellar quantities, stellar populations and kinematics, history of the galaxy, extrasolar planets, habitable zones, and the search for life elsewhere. NASA and the NSF have collaborated to support the effort. Goals include providing a robust, Web-based data set for use by researchers and the public regarding stellar objects within 25 pc of the Earth; characterizing stars especially in terms of astrobiology-related properties such as age, metallicity, variability, substellar companions, and circumstellar planetary "exozodi" dust; and supporting definition of research programs using upcoming NASA Origins facilities such as SIRTF (Space Infrared Telescope Facility), SOFIA (Stratospheric Observatory for Infrared Astronomy), SIM (Space Interferometry Mission), and TPF (Terrestrial Planet Finder).

It is anticipated that there will be more than 10,000 stars, brown dwarfs, and planets within 25 pc when the NStars sample is complete. These are the stars that offer the best promise for answers to questions about the census of the Sun's neighbors, how many stars have planets circling them, and whether or not any of these planets harbor life. In order to have the best sample possible to answer these questions, CTIOPI hopes to discover a lot of hidden treasure and to make a significant contribution to the neighborhood.

Solar Magnetic Fields—Application of Adaptive Optics Offers New Insights

Michael Sigwarth and Thomas Rimmele

The NSO low-order adaptive optics system at the Dunn Solar Telescope (DST) has made it possible to obtain the first high-resolution and low-noise Stokes spectra of identified individual flux tubes in the solar magnetic network. Flux tubes are the smallest, intense flux concentrations known in the solar photosphere. Because of their large numbers, they contribute significantly to global solar phenomena. In the G-band at 430 nm, flux tubes become visible as bright points. The typical sizes of such bright points range between 150 to 300 km in diameter.

We used the HAO/NSO Advanced Stokes Polarimeter (ASP) to investigate magnetic fields in the quiet Sun network and internetwork. High-resolution images in the G-band were obtained simultaneously. Bright points, visible in the high-resolution images, could also be identified in the Stokes spectra. AO allowed the increase of integration time of the polarimetric measurements to 4.2 seconds and enhanced the signal-to-noise ratio while the spatial resolution was still limited by the ASP pixel size of 0.4″ × 0.4″.

It was also possible to measure for the first time the field strength of an identified individual flux tube to 0.1 ± 0.01 T. The flux tube itself remained spatially unresolved, but

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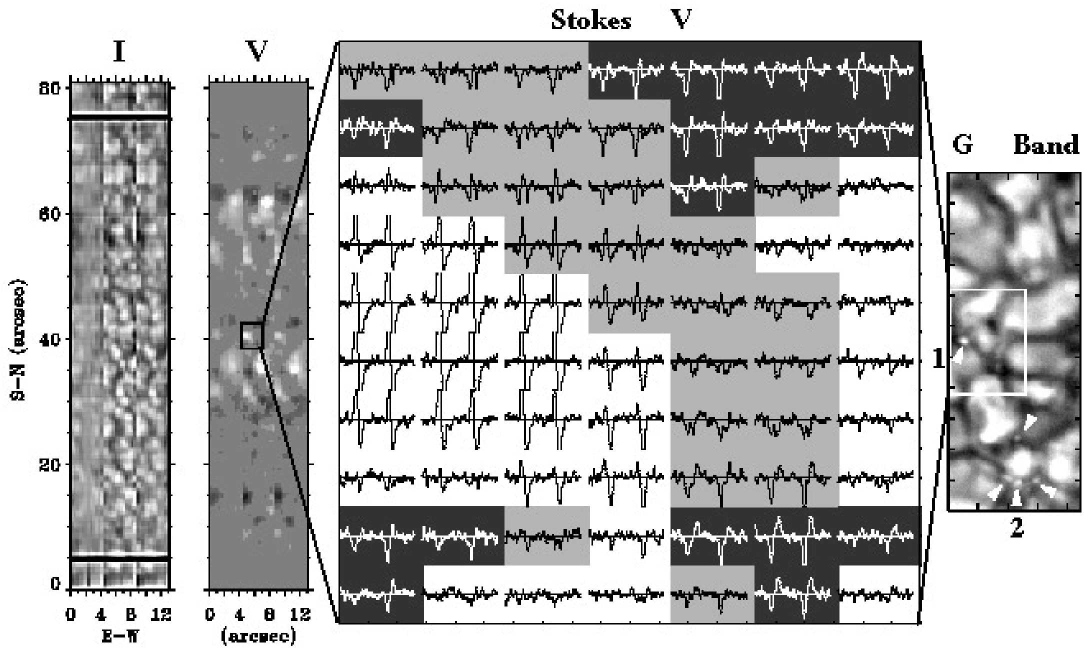
Adaptive Optics continued

the analysis of individual Stokes-V spectra suggests that the flux tube is embedded in a much weaker and probably turbulent magnetic field. The source of this field could be a turbulent field generated locally by granular flows, "recycled" magnetic flux from dissolved active regions, or returned flux from the flux tube itself.

A new Stokes polarimeter that is currently under construction for the DST (see article in this newsletter) will allow better use of the high resolution that AO provides and will enhance the capability to obtain more detailed information on the structure of flux tubes and the weaker magnetic fields in the solar photosphere.

The NSO AO System was described in *NOAO Newslsetter* 56 (p. 36). For additional information, see *http://www.sunspot.noao.edu/AOWEB/*.



Stokes-V spectra in the area of a magnetic flux tube in the solar magnetic network. The G-band image (right) shows an individual bright point [1] and a group of bright points [2] within the granulation. The area within the white rectangle is represented by the spectra plotted in the middle square: white background indicates positive polarity (or no signal); black background, negative polarity; and gray background, weak and complex profiles. Large amplitude Stokes-V profiles are located at the position of the bright point. These points are surrounded by very faint signals, which indicate a weaker field around the intense flux tube. The continuum intensity [I] and Stokes-V amplitude maps obtained from three spatial scans with the Advanced Stokes Polarimeter are shown on the left. The interference of signals from the flux tube and an opposite polarity field in the upper left corner could be the reason for the complex profiles in between them. For the first scan, the AO was not correcting the wavefront aberrations. The investigated area is within the black square.