PlanetQuest™

The Planet-Wide Observatory

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PlanetQuest™…The Planet-Wide Observatory

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SUMMARY

PlanetQuest will make it possible for millions of people, using their computers and our data, to search the galaxy for undiscovered planets, catalog and classify millions of new stars, have fun learning, and advance the world's scientific knowledge. What makes this "planet quest" not only feasible but also accessible to everyone, from a schoolchild to a PhD, is PlanetQuest's astronomical observing network, distributed computing platform, and Transit Detection Algorithm (TDA)—a special mathematical signal detection technique codeveloped by one of PlanetQuest's founders. This signal detection technique has been used to search for extrasolar planets over the past decade and can be used to identify the transit of a planet in front of its parent star by detecting a very slight drop in the star's brightness that will last only a matter of hours.

The TDA (and several additional detection algorithms) uses mathematical techniques to analyze the brightness of a star over time (called a "light curve") and compare it with computer-generated hypothetical models of planetary transits (and other events) to see if the brightness variations observed in the light curve of the star match any of the models. Because the actual (observed) light curve must be compared with millions of such models in order to identify any real planetary-caused events that may have occurred, the search for planets is ideally suited to distributed computing. The power of millions of people's computers can be harnessed to perform a search for planetary transits around millions of stars—a task once considered essentially impossible involving tens of thousands of years of computing time to search millions of stars for planets.

PlanetQuest is a nonprofit organization that was formed in 2004 by Laurance Doyle, PhD, an internationally known and respected astrophysicist, coauthor of the TDA, and Principal Investigator at the SETI Institute; David Gutelius, PhD, cofounder of Ishtirak (a technology consultancy firm serving Fortune 100 companies), a management consultant for technology start-ups, and a Stanford University visiting scholar; and entrepreneur Jeremy Crandell, cofounder of Brightmail, an antispam software development corporation that was recently purchased by Symantec.

MISSION

The **unifying mission** of PlanetQuest is to create global participation in the discovery of planets around other stars. It will enlist the active participation of tens of millions of people, at all educational levels. PlanetQuest is designed to provide a new level of participation in scientific discovery, one in which people—especially children—collaborate on a global scale to discover new worlds. As the Internet has made it possible to share vast amounts of information among people in ways not previously possible, PlanetQuest will allow free participation by everyone in the actual discovery of worlds never before known. These will be real discoveries; PlanetQuesters will be discovering new worlds, and receiving credit for their discoveries.

Crowded star region in Sagittarius; NASA-HST image

The **scientific mission** of PlanetQuest is the discovery—by PlanetQuesters—of thousands of new planets in our galaxy, the Milky Way. Some of these planets (around the smallest stars we'll be observing) could be of the right size and distance from their star to potentially support life, and as the PlanetQuest network grows, it will increase the possibility of finding even more of these smaller "terrestrial-type" planets within the circumstellar habitable zone around the smallest stars (M-dwarfs).

The **educational mission** of PlanetQuest is to provide the largest Web-based platform for astronomy, computer science, and general math and science education yet designed, reaching virtually all educational levels with the philosophy of learning through real discovery. Online tutorials for PlanetQuest participants will provide instruction at various levels of educational development—for school children up to about age 12 (Level 1), high school students (Level 2), the general public (Level 3), the scientifically literate (Level 4), and graduates in the sciences and astrophysics (Level 5).

Virtually every participant will receive credit for discoveries because every participant is sure to make a unique discovery about the particular stars they are searching for planets around. Initially, about one in 10,000 PlanetQuesters should also find new planets, but this discovery ratio will improve as we build our own larger telescopes to reach farther and deeper into the galaxy for new and more sunlike stars to observe.

ORIGINS OF PLANETQUEST

In the latter part of 2000, while SETI@home was in the process of attracting millions of users to process radio signals in the search for extraterrestrial technology, astrophysicist Laurance Doyle first asked the question: What if we could harness the power of millions of people operating millions of computers to also discover planets in our galaxy? And what if, in the process of the search, people learned about astronomy and science and computing and felt that they really were finally participating in the actual discovery of new worlds—where, indeed, no one had gone before? And what if, in the process of the search, people from the Americas, China, India, the Middle East, Africa, Australia—the whole world—collaborated with each other, sharing knowledge and ideas, while searching for other worlds? Perhaps such a galactic perspective on our place in the universe could help us see that we all share this one tiny planet, and help us better understand what goes into making our own little world precious.

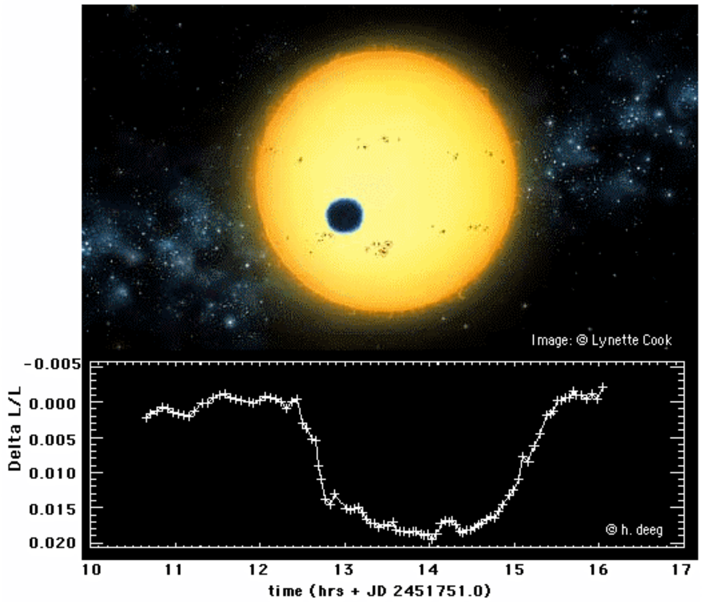
Earlier, from 1994, Doyle and collaborators had authored a series of papers appearing in scientific journals, including *Scientific American*, describing this method for detecting planets around other stars. The method uses images of hundreds of thousands of stars from telescopes at observatories around the world to detect the shadow of a planet as it crosses in front of a star.

Teaming up with partners Gutelius and Crandell in early 2004, Doyle began developing a model for PlanetQuest that would offer a robust innovative distributed computing platform for the creation of the world's largest planet detection network—that would be free to all who wished to participate. Using the power of distributed computing, this project would involve people in a way and on a scale that could set an example for future scientific and educational ventures. PlanetQuest hopes to be the world's largest astronomy educational facility, the largest "collaboratory" for planet discoveries, and the largest computational network, dedicated to bringing the actual discovery of other worlds to everyone who has a computer.

HOW IT WORKS

Since the creation of the modern telescope in 1608, only three new planets—all in our own solar system—had been discovered. But since 1995, over 150 planets around other stars have been discovered. With PlanetQuest in operation, hundreds of additional new planets could be discovered within the next several years, by people who are not trained in astrophysics, mathematics, or signal detection techniques.

The science behind PlanetQuest is fairly straightforward. Using the TDA (and other detection algorithms) and observational data downloaded from the PlanetQuest website, one can find planets around other stars by measuring a drop in the brightness of a star as a planet crosses, or transits, in front of it. But in order for us to witness this event, the orbit of the planet has to move across our line of sight to the star, and this happens for only a few percent of the stars in our night sky. Thus, the more stars being observed, the greater the chance for a planetary orbit to be aligned correctly, and the greater the probability of discovery.



PlanetQuest will focus telescopes on extremely dense star regions, such as the star clouds in the constellation Cygnus in the Northern Hemisphere, and the center of the galaxy in Sagittarius in the Southern Hemisphere. Each image from a given telescope will include many tens of thousands of stars, and PlanetQuest's software will allow participants to obtain facts about the stars they are working on based on their brightness, color, and other characteristics.

The data from these images (the brightness variations of the stars) will be distributed to millions of computers, and software incorporating the Transit Detection Algorithm (TDA) will compare each star's brightness variations with all possible planetary transit models to see if a planet is present in a PlanetQuester's data. This TDA approach has been adopted for data analysis by the NASA Kepler spacecraft mission to be launched in 2008.

PlanetQuest users will be able to compare and share information about the stars they are working on, ask questions of PlanetQuest's professional astronomers, and work through some of the PlanetQuest educational materials with the goal of being able to "graduate" to a higher level in the PlanetQuest educational setting (for example, from grammar school Level 1 to high school Level 2). Of course, the discovery of a planet is determined not by a participant's educational level but by whether a particular star actually has a planet whose orbit moves across (transits) the star to our line of sight. This is certainly not determined by PlanetQuest, and such unknowns illustrate the fact that PlanetQuesters will be doing real science and making real discoveries at the frontiers of knowledge.

When a participant has discovered a new fact about a star or possibly has a new planet candidate, PlanetQuest will acknowledge and record that finding and the discoverer's name in the PlanetQuest *Discoveries Catalog*. Planet candidates will then need to be verified by checking the light curve with additional confirming data. Virtually all PlanetQuesters will receive credit for discoveries of astronomical importance. Some will be credited with the discovery of new planets, as well. Their names will become part of astronomical history, and their new worlds may be studied for centuries to come.

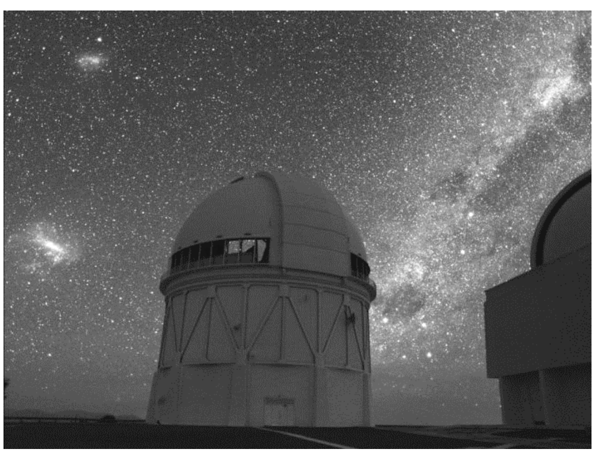
DATA ACQUISITION

PlanetQuest's first official observing season begins in June 2005 with observations at two telescopes—the Crossley 0.9-meter telescope at the University of California's Lick Observatory in the Northern Hemisphere and the Siding Spring 1.0-meter telescope in Coonabarabran, Australia in the Southern Hemisphere.

In April 2005, entrepreneur Dill Faulkes presented PlanetQuest with what is essentially a $20 million gift: two-thirds observing time at each of his twin 2-meter telescopes—the Faulkes Telescope Project—one on the island of Maui, Hawaii in the Northern Hemisphere, and the other at Siding Spring Observatory. The telescopes are the largest in the world dedicated to the public understanding of science.

We have been invited to join the SMARTS observing consortium, providing long-term access to the smaller telescopes at Cerro Tololo Inter-American Observatory, as well as an observing consortium at Calar Alto Observatory in southern Spain. Both of these collaborations will begin in 2006.

With a response similar to that received by SETI@home—millions of users—PlanetQuest will soon require additional 2.5-meter telescopes, each equipped with 4,000 × 4,000 array CCD imaging cameras, with a minimum observing schedule of about 200 nights per year on each telescope. This will yield thousands of hours of data on several million stars that PlanetQuest users can classify and search for planets.



Cerro Tololo Inter-American Observatory, Chile

To expand the project to 20 million participants, PlanetQuest will need to build its own dedicated 2.5-meter telescopes (in both the Southern and Northern Hemispheres) in several sites—for example, Chile (we have been invited to do so at the Cerro Tololo Inter-American Observatory). With 2.5-meter telescopes in the Southern Hemisphere we would have access to virtually all the 170 million stars in the center of the Milky Way galaxy catalogued to date (by the OGLE project), with the discovery of many more extending this number to over a billion stars over the following decade.

To accommodate an even greater number of PlanetQuest participants in the future—up to perhaps 50 million users—even larger telescopes could be established in both hemispheres, and it is not inconceivable that a mission built after the design of the NASA Kepler spacecraft could be launched that could constantly access the many tens of millions of stars required for so many PlanetQuest users. In other words, there will be no lack of stars for PlanetQuest, and facilities are available or could become available for any number of expected users into the foreseeable future.

DATA PROCESSING

PlanetQuest has developed and tested all the basic TDA software specific to the detection of planets (additional detection algorithms are under development) and is currently adapting this software to the distributed computing environment using the BOINC platform, initially developed at the University of California, Berkeley, for SETI@home and other projects.

The PlanetQuest Collaboratory will work on any operating system. A participant needs only to download the Collaboratory from the PlanetQuest website. As its name suggests, the Collaboratory is designed to encourage frequent interaction, self-education, and a deeper understanding of astronomy and science.

PlanetQuest will build a central online archive, catalog of discoveries, and databases of other information for users. The *Discoveries Catalog*—available online to all participants—will list the name of each PlanetQuester who worked on a particular star and what they discovered. The catalog will also list the names of people who discovered new planets. With millions of stars and thousands of planets to be discovered and catalogued, the archive will be highly robust, secure, and easily accessible. For this, PlanetQuest draws on expertise developed for the database management of the NASA Cassini Saturn images that are currently being transmitted to Earth from that orbital mission (see personnel below).

TIMELINE

PlanetQuest operations will launch in **late 2005/early 2006** with a limited public release of the Collaboratory software platform to 50,000 PlanetQuest Charter Members.

In **late 2006** or **early 2007**, PlanetQuest will launch the worldwide Collaboratory with the goal of engaging up to about 4 million participants within the year. We also hope to add an optical SETI component to the PlanetQuest Collaboratory so that users can simultaneously look for planets and participate in the newest search techniques for possible extraterrestrial technology (these techniques detect nanosecond *optical* pulses from stars rather than narrow-band *radio* signals).

During **2007**, we plan to introduce a scientific, refereed publication (*Proceedings of the PlanetQuest Academy*) and subsidiary products, such as educational games (*Here Comes Andromeda!*), science videos, radio programs, and other educational products.

By **2008**, we expect to see the expansion of the program to 10 million participants, resulting in the discovery of possibly thousands of new planets. Finally, we envision the launch of an international event to discuss major findings and discoveries, with publication of the proceedings online. By **2009**, PlanetQuest should be self-sufficient.

FUNDING

Revenues to support the launch, growth, and operation of PlanetQuest will be raised from several sources:

- Corporate sponsorships
- PlanetQuest members—individual donors
- Online advertising—sponsor logos
- Licensing of PlanetQuest products, such as games and educational materials
- Fundraisers and annual conferences
- Foundation and government grants
- Publications

A key to the successful perpetuation of PlanetQuest is that, through advertising, PlanetQuest Academy memberships, and other products, we expect PlanetQuest to be self-sufficient within the first five years. Although the actual planet searching process will be free to all who want to participate, there will be many avenues through which those who wish to advertise, receive additional educational materials, go on PlanetQuest-sponsored expeditions and/or contribute financially, can participate at a higher level.

THE PEOPLE OF PLANETQUEST

Some of the research that is going into PlanetQuest dates back almost two decades, before the first extrasolar planets were discovered. We are also advised by a panel of world-renowned experts in science and education.

Dr. Laurance Doyle, President and Cofounder

Laurance Doyle is a Principal Investigator at the SETI Institute, codirector of the TEP (Transit of Extrasolar Planets) observing network, codeveloper (with Hans Deeg and Jon Jenkins) of the Transit Detection Algorithm (TDA) PlanetQuesters will be using (which was also adopted by the NASA Kepler spacecraft mission for confirming the detection of extrasolar planets), a coinvestigator on the National Science Foundation (NSF) Vulcan South Project and the Instituto de Astrofísica de Canarias PASS (Permanent All-Sky Survey) project, and was a consultant on stellar spectral classification to the NASA Kepler mission. He helped to develop two new photometric extrasolar planet detection methods—an extension of the triple star system detection method known as the eclipsing binary timing method (with Deeg) and the reflected light phase method (with Jenkins) in addition to contributions to the transit detection method. He teaches the classes “Life in the Universe” and “Light and Optics” at the University of California at Santa Cruz and lectures widely.

Dr. David Gutelius, Executive Director and Cofounder

David Gutelius brings a decade of nonprofit and start-up management experience at SRI International, and has led programs funded by NSF, the Department of Homeland Security, the

Department of Education, USAID, the Ford and Mellon Foundations, and many others. He cofounded Ishtirak, a technology consultancy firm serving Fortune 100 companies in the developing world, and has served as a management consultant for technology companies at the start-up stage. He is coinvestigator with Laurance Doyle of the F_c Project at the SETI Institute and Stanford University, focusing on the social histories of astronomical discoveries. He is also a visiting scholar at Stanford, where he teaches and leads cutting-edge research on social networks, economic history, technology and innovation.

Dr. Robert Slawson, Observing Astronomer and Image Processing Astronomer

Robert Slawson is a Research Associate with the Rochester Institute of Technology and advisor to Kodak on CCD imaging systems and their application to astronomy. He has had wide experience in the classification of stars, precision photometry, and astronomical data reduction procedures. He has been a staff astronomer at the Carnegie Foundation's La Silla Observatory in Chile for several years.

Dr. Doug Caldwell, Observing Astronomer

Douglas Caldwell is a Principal Investigator with the SETI Institute and a Principal Investigator with the NSF Vulcan South Project, a telescope to detect transiting extrasolar planets from the Amundsen-Scott South Pole Station in Antarctica. He is also Instrument Scientist on the NASA Kepler mission and served as the interim director of the Science Operations Center for this mission.

Dr. Zoran Ninkov, Astronomical Imaging Science Consultant

Zoran Ninkov is an Associate Professor at the Rochester Institute of Technology. He is currently working on the development of novel two-dimensional detector arrays for use in spaceborne and ground-based astronomical imaging and spectroscopy, as well as the development of image processing techniques for optimal analysis of such two-dimensional (InSb, NICMOS, CCD, CID and APS arrays) astronomical image data, as well as other projects.

Dr. Hans Deeg, Observing Astronomer and Image Processing Astronomer

Hans-Jörg Deeg is codirector of the TEP (Transit of Extrasolar Planets) observing network, an astrophysicist with the Instituto de Astrofísica de Canarias (IAC), Spain, and Principal Investigator for the IAC PASS (Permanent All-Sky Survey) project to detect extrasolar planets. Together with L. Doyle he developed the eclipsing binary minimum timing method for detecting planets around close binary stars.

Dr. Jon Jenkins, Signal Detection Astronomer

Jon Jenkins is a coinvestigator with the NASA Kepler mission to detect Earthlike planets in the circumstellar habitable zones of sunlike stars, and a Principal Investigator with the SETI Institute. He is in charge of transit signal detection and confirmation algorithms for this $500 million wide-angle orbiting telescope mission. Together with L. Doyle he developed the phase-reflection method for detecting giant inner planets around dwarf-type stars.

Dr. David Carico, Education Program Manager

David Carico holds a BS in engineering physics from UC Berkeley and a PhD in physics from the California Institute of Technology (Caltech), where he studied infrared galaxies. He has taught physics and astronomy for fifteen years at various institutions, from small private colleges to large state universities. He is the author of an innovative physics textbook for high school students, and is currently developing an introductory college astronomy textbook and a quantum mechanics book for sixth graders. He is investigating (with Doyle) quantum limits on observations of gravitational lensing, and teaches part-time at both San Francisco State University and Santa Rosa Junior College.

Ellen Blue, Director of Publications

Ellen Blue founded and operates Travis House Publications in Menlo Park, CA and is the publisher of *Circumstellar Habitable Zones*, a NASA conference proceedings on the detection and characterization of environments for life in the universe. She has been a senior staff editor/production manager at SRI International/SRI Consulting, has worked as a contract editor, and has compiled, designed, and edited print and Web-based newsletters as well as research publications for the chemical industry. She is a coauthor of several scientific journal articles and conference proceedings on the search for extrasolar planets and has assisted in long-time-line photometric observations to detect extrasolar planets at the University of California's Lick Observatory.

Sylvia Paull, Marketing and Public Relations

Sylvia Paull specializes in publicity and strategic marketing services for high-tech businesses and organizations, such as CNET, Ask Jeeves, and the Electronic Frontier Foundation. She is also founder and director of Gracenet (www.gracenet.net), a networking group for high-tech women based in the San Francisco Bay Area, and founder/host of the Berkeley Cybersalon, a monthly technology forum (www.berkeleycybersalon.com). She was formerly marketing director for Software Ventures; coproducer of *Science Editor*, a radio show about science distributed by CBS; and a freelance writer for *Wired* magazine.

David Rowland, Collaboratory Development Director

David Rowland holds a BS in electrical engineering from UC Berkeley and an MS in mathematics from the University of Washington. He has made a career in software, principally in real-time control systems and telecommunications, but ranging over many other areas. He has held senior management positions at several San Francisco Bay Area technology companies, managing commercial software product development. He teaches computer science courses at the University of California Extension.

Brad Silen, Project Manager

Brad Silen has been a part of many successful software ventures over his twenty years of experience in software management. Brad brings a special brilliance to interactive design, working to develop the original SETI@home interface as well as for clients including Berkeley Systems, Sun, Compaq and Apple.

Dr. Jay Doane, Collaboratory Developer

Although Jay's background is in astrophysics, he's worked over the last decade as a software engineer. He has experience in a variety of development areas, but has specialized in secure, persistent, concurrent distributed systems.

Charlie Fenton, Lead Collaboratory Programmer

Charlie Fenton brings forty years of experience in software design and implementation to PlanetQuest. In addition to creating the Macintosh GUI and screen saver for SETI@home classic, he contributed extensively to its implementation and maintenance across all supported platforms. Currently part of the UC Berkeley BOINC development team, he has written software for Apple Computer and others.

Kimberly Lefkowitz, Lead Collaboratory Programmer

Kimberly Lefkowitz graduated with a physics degree from Vassar College and is looking into PhD programs beginning in the fall of 2005. She has worked extensively on the BOINC-powered Einstein@home project. Her research interests include cosmology, gravitational waves and cosmic strings.

Neil Heather, Database/System Administrator

Neil Heather is a database manager in charge of the Ring Imaging Center for the NASA Cassini-Huygens Mission to Saturn & Titan. He has been a programming and web design/access specialist with NASA Ames Research Center for over a decade.

BIBLIOGRAPHY

The PlanetQuest team has been at the forefront of planet detection and related disciplines. Here's a list of recent original research on Extrasolar Planet Detection.

Alonso, R., T.M. Brown, G. Torres, D.W. Latham, A. Sozzetti, G. Mandushev, J.A. Belmonte, D. Charbonneau, H.J. Deeg, E.W. Dunham, F.T. O'Donovan, R.P. Stefanik (2004), "TrES-1: The Transiting Planet of a Bright K0V Star," *ApJ*, 613L, 153 (astro-ph/040842).

Caldwell, D.A., W.J. Borucki, R.L. Snowden, J.M. Jenkins, L.R. Doyle, Z. Ninkov, and M. Ashley (2004), "Detecting Extrasolar Planet Transits from the South Pole," in *Bioastronomy 7*, in press.

Deeg, H.J. (2004), "Transit Detection on Eclipsing Binary Systems," in proc. of "Planetary Transit Detection: Stellar Noise and False Alarms" (Berlin, Dec. 2003), P. Barge, ed., in print. Summary (.pdf) and slides of talk (.pps).

Deeg, H.J. (2004), "Should Eddington Concentrate on M-Stars?," in Proc. 2nd Eddington workshop on "Stellar Structure and Habitable Planet Finding," (Palermo, Italy, Apr. 2003), F. Favata and S. Aigran, eds., ESA publication SP-538, p. 231.

Deeg, H.J., R. Alonso, J.A. Belmonte, K. Alsubai, and L.R. Doyle (2004), "Current Status of the Permanent All Sky Survey (PASS) for the Detection of Transiting Planets," in proc. of "Jornadas Científicas 250 Años de Astronomía en España" (San Fernando, Spain, Sept. 2003), M. Vallejo et al., eds., in print.

Deeg, H-J., R. Alonzo, J.A. Belmonte, K. Alsubai, and L.R. Doyle (2004), "An All Sky Survey for the Detection of Transiting Extrasolar Planets," *PASP*, in press.

Deeg, H-J., R. Alonzo, J.A. Belmonte, K. Alsubai, and L.R. Doyle (2004), "The Permanent All Sky Survey for Extrasolar Planets," *Proceedings of European Extrasolar Planets Workshop*, in press. *****

Deeg, H.J., R. Alonso, J.A. Belmonte, K. Alsubai, K. Horne, A.C. Cameron, and L.R. Doyle (2004), "A Prototype for the PASS Permanent All Sky Survey," *Astronomische Nachrichten* 325:643 (astro-ph/0409557).

Deeg, H.J., R. Alonso, J.A. Belmonte, K. Alsubai, K. Horne, L.R. Doyle (2004), "PASS, an All-Sky Survey for the Detection of Transiting Extrasolar Planets and for Permanent Variable Star Tracking," *PASP* 116:985 (astro-ph/0408589).

Doyle, L.R., and H.-J. Deeg (2004), "Timing Detection of Eclipsing Binary Planets and Transiting Extrasolar Moons," in *Bioastronomy 7*, in press.

Jenkins, J.M., and L.R. Doyle (2004), "Detecting Reflected Light from Close-In Giant Planets Using Space-Based Photometers," *Astrophysical Journal* 595:429–445.

Alonso, R., J.A. Belmonte, H. Deeg, T.M. Brown (2003), "STARE Detection Capabilities," in proc. of "Scientific Frontiers in Research on Extrasolar Planets," D. Deming and S. Seager, eds., ASP Conf. Series vol. 294, pp. 371–374.

Alonso, R., H. Deeg, T.M. Brown, J.A. Belmonte (2003), "Strategies to Recognize False Alarms in Transit Experiments: Experiences from the STARE Project," in proc. of the second Eddington workshop on "Stellar Structure and Habitable Planet Finding" (Palermo, Italy, Apr. 2003), F. Favata et al., eds., ESA publication SP-538, p. 255.

Castellano, T., L. Doyle, and D. McIntosh (2003), "The Visibility of Earth Transits," in *Planetary Systems in the Universe: Observations, Formation and Evolution*, ASP Conf. Ser., A.J. Penny, P. Artymowiez, A.-M. Lagrange, and S.S. Russell, eds.

Deeg, H.J., R. Alonso, J.A. Belmonte, K. Alsubai, L.R. Doyle (2003), "Simulations for the Permanent All Sky Survey (PASS) Experiment," in proc. of the XIXth IAP colloquium "Extrasolar Planets, Today and Tomorrow" (Paris, July 2003), J.-P. Beaulieu et al., eds., ASP Conf. Proc., in print.

Deeg, H.J., L.R. Doyle, V.J.S. Béjar, J.E. Blue, S. Huver (2003), "Minimum Times of Several Eclipsing Binaries," *IBVS* 5470.

Delgado-Donate, E.J., C. Munoz-Tunon, H.J. Deeg, J. Iglesias-Paramo (2003), "Dwarfs after Mergers? The Case of NGC520, NGC772, Arp141, NGC3226/7, NGC3656 and Arp299," *A&A* 402:921.

Deeg, H.J. (2002), "Detection of Terrestrial Planets and Moons with the Photometric Transit Method," in proc. of 36th ESLAB symposium on "Earth-like Planets and Moons," B. Foing and B. Battrick, eds., ESA publication SP-514, pp. 237–243.

Deeg, H.J. (2002), "Der lange Weg vom Schüler zum Profi-Astronomen," in "Festschrift zum 25-jährigen Bestehen der Astronomischen Vereinigung Weikersheim" (in German).

Deeg, H.J. (2002), "PASS—A Permanent All-Sky Survey for the Detection of Transits," in proc. of the first Eddington workshop on "Stellar Structure and Habitable Planet Finding," F. Favata et al., eds., ESA publication SP-485, pp. 273–276.

Deeg, H.J., and R. Garrido (2002), "Descubrir Mundos en Transito," in *IAA: Información y Actualidad Astronómica*, May 2002, pp. 3–5.

Deeg, H.J., K. Horne, and Eddington Science Team (2002), "Eddington's Planet Finding Capabilities," in proc. of the first Eddington workshop on "Stellar Structure and Habitable Planet Finding," F. Favata et al., eds., ESA publication SP-485, pp. 123–128.

Doyle, L.R., and H.-J. Deeg (2002), "Detection of Large Terrestrial Planets Around M and K Dwarf Stars in Orion by Transit Photometry," in *Stellar Structure and Habitable Planet Finding: Proceedings of the First Eddington Workshop*, ESA SP-485, pp. 277–279.

Deeg, H.J., R. Garrido, A. Claret (2001), "Probing the Stellar Surface of HD 209458 from Multicolor Transit Observations," *New Astronomy*, 6/2, 51 (electronic Table 1).

Doyle, L.R., H.J. Deeg, J.M. Jenkins (2001), "Discovering Worlds in Transits," *Astronomy Magazine* (US), March 2001, p. 38.

Castellano, T., J. Jenkins, D.E. Trilling, L. Doyle, and D. Koch (2000), "Detection of Planetary Transits of the Star HD 209458 in the Hipparcos Data Set," *Astrophysical Journal Letters* 532:L51–L53.

Deeg, H.J. (2000), "Some Aspects of Exoplanets Detection with the Transit Method," *Earth Moon and Planets* 81:73–78.

Deeg, H.J., F. Favata, and Eddington Science Team (2000), "Detection Limits in Space-based Transit Observations," in proc. of "Disks, Planetesimals and Planets" (Tenerife, Jan. 2000), F. Garzon et al., eds., ASP Conf. Ser. vol. 219, pp. 578–583.

Deeg, H.J., K. Horne, F. Favata, and Eddington Science Team (2000), "Planet Detection Capabilities of the Eddington Mission," proc. for IAU Symp. 202, "Planetary Systems in the Universe," A.J. Penny et al., eds., IAU Symp. pub. S202, in print.

Doyle, L.R., J.E. Blue, L. Rottler, H.-J. Deeg, and M. Navaarate (2000), "From CM Draconis to the Crowded Field BW3: Aspects of the Search for Extrasolar Planets Around Small Eclipsing Binaries," in *Bioastronomy '99: A New Era in Bioastronomy*, G.A. Lemarchand and K.J. Meech, eds., ASP Conf. Ser. vol. 213 (Astronomical Society of the Pacific, San Francisco), pp. 159–165.

Doyle, L.R., H.-J. Deeg, and T.M. Brown (2000), "Searching for Shadows of Other Earths," *Scientific American*, September 2000.

Doyle, L.R., H.-J. Deeg, V.P. Kozhevnikov, J.E. Blue, B. Oetiker, L. Rottler, E. Martin, Z. Ninkov, R.P.S. Stone, J. Jenkins, J. Schneider, E.W. Dunham, M.F. Doyle, and E. Palaiologou (2000), "Observational Limits on Terrestrial-Sized Inner Planets Around the CM Draconis System Using the Photometric Transit Method with a Matched-Filter Algorithm," *Astrophysical Journal* 535:338–349.

Jenkins, J.M., L.R. Doyle, and H.-J. Deeg (2000), "Ground-Based Photometric Detection of Extrasolar Planets," *Acta Astronautica* 46:693–699.

Oetiker, B., N. Duric, J. McGraw, T. Wiliams, D. Jackson, H.J. Deeg, M. Scheibner, D. Garcia, E. Wilcox (2000), "Searching for Companions to Late-Type M Stars," in proc of "From Giant Planets to Cool Stars," C.A. Griffith and M.S. Marley, eds., ASP Conf. Ser. vol. 212, p. 88.

Quirrenbach, A., J. Cooke, D. Mitchell, N. Safizadeh, H.J. Deeg, and EXPORT Team (2000), "Export: Search for Transits in Open Clusters with the JKT and Lick 1m Telescopes," in proc. of "Disks, Planetesimals and Planets" (Tenerife, Jan. 2000), F. Garzon et al., eds., ASP Conf. Ser. vol. 219, p. 566.

Deeg, H.-J., L.R. Doyle, V.P. Kozhevnikov, J.E. Blue, L. Rottler, and J. Schneider, "A Search for Jovian-Mass Planets Around CM Draconis Using Eclipse Minima Timing," *Astronomy & Astrophysics* 358:L5–L8.

Deeg, H.-J., L.R. Doyle, V.P. Kozhevnikov, E. Martin, E. Palaiologou, J. Schneider, C. Afonso, E.T. Dunham, J.M. Jenkins, Z. Ninkov, R. Stone, and P.E. Zakharova (1998), "A Photometric Search for Transits of Extrasolar Planets: Observations and Photometric Analysis of CM Draconis," *Astronomy & Astrophysics* 338:479–490.

Deeg, H.J., C. Munoz-Tunon, G. Tenorio-Tagle, E. Telles, J.M. Vilchez, J.M. Rodriguez-Espinosa, P.A. Duc, and I.F. Mirabel (1998), "A Catalogue of Dwarf Galaxy Candidates Around Interacting Galaxies," *A&AS* 129:455.

Doyle, L.R., H.-J. Deeg, J.M. Jenkins, J. Schneider, Z. Ninkov, R.P.S. Stone, J.E. Blue, H. Götzger, B. Friedman, and M.F. Doyle (1998), "Detectability of Jupiter-to-Brown-Dwarf-Mass Companions Around Small Eclipsing Binary Systems," in *Brown*

Dwarfs and Extrasolar Planets, ASP Conference Proceedings, R. Rebolo, E. L. Martin, and M.R.Z. Osorio, eds., ASP Conf. Ser. vol. 134, 224–231.

Martin, E.L., H. Deeg, L. Doyle, and J. Schneider (1998), “Planets in CM Draconis: A Multi-Site Photometric Approach,” in *Infrared Space Interferometry: Astrophysics and the Study of Earth-Like Planets*, C. Eiroa et al., eds., Kluwer Academic Pub. 215, 59.

Deeg, H.J (1997), “Photometric Detection of Extrasolar Planets by the Transit Method,” in *Brown Dwarfs and Extrasolar Planets*, R. Rebolo et al., eds., ASP conf. ser. vol. 134, p. 216.

Deeg, H.J., E.L. Martin, L. Doyle, J. Jenkins, J. Schneider, M. Chevreton, M. Palaiologou (1997), “The TEP Network—A Search for Transits of Extrasolar Planets: Observations of CM Draconis,” *Astronomical & Astrophysical Transactions* 13:233–243.

Deeg, H.-J., E. Martin, J. Schneider, M. Chevreton, L.R. Doyle, J.M. Jenkins, Z. Ninkov (1997), “Observations to Detect Terrestrial Planets Around CM Draconis,” *Astron. & Ap. Trans*. 23:23–43.

Brandmeier, S., and L.R. Doyle (1996), “Modeling of Extrasolar Planetary Transits in Eclipsing Binary Systems,” *Circumstellar Habitable Zones: Proceedings of the First International Conference*, Travis House Publications, Menlo Park, CA, pp. 251–263.

Doyle, L.R. (1996), “In the Wink of a Star,” *Mercury*, May/June 1996, pp. 51–53.

Doyle, L.R., E.T. Dunham, H.-J. Deeg, J.E. Blue, and J.M. Jenkins (1996), “Ground-Based Detection of Terrestrial-Sized Extrasolar Planets: U.C. Lick Observations of CM Draconis,” *J.G.R. Planets* 101:14823–14829.

Jenkins, J.M., L.R. Doyle, and K. Cullers (1996), “A Masked-Filter Method for Ground-Based Sub-Noise Detection of Extrasolar Planets in Eclipsing Binaries: Application to CM Draconis,” *Icarus* 119:244–260.

Schneider, J., and L.R. Doyle (1995), “Ground-Based Detection of Terrestrial Extrasolar Planets by Photometry: The Case for CM Draconis,” *Earth, Moon, and Planets* 71:153–173.

Hale, A., and L.R. Doyle (1994), “The Photometric Detection of Extrasolar Planets Revisited,” *Astrophy. & Space. Sci*. 212:335–341.

Doyle, L.R. (1985), “Assisting the Detection of Extrasolar Planets Through the Determination of Stellar Space Orientations,” in *The Search for Extraterrestrial Intelligence*, IAU Symposium 112 (Boston, MA, 1984), D. Reidel Pub. Co., Dordrecht, pp. 97–100.

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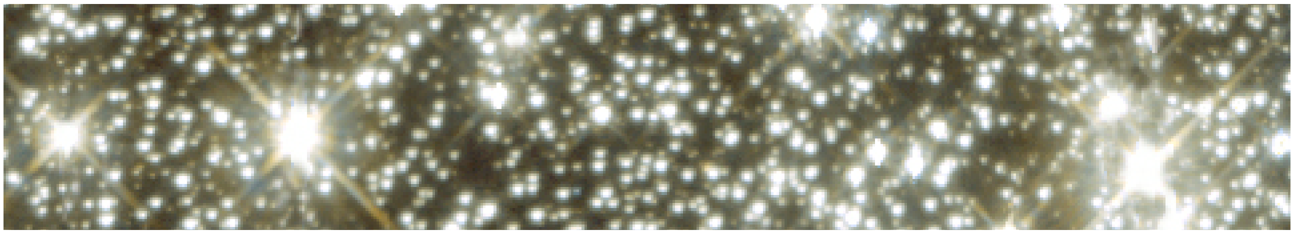

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