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NEWS & ANNOUNCEMENTS

There were 71 new TNO discoveries announced since the previous issue of *Distant EKOs*:


and 19 new Centaur/SDO discoveries:


Reclassified objects:

- 2002 GG166 (TNO → SDO)
- 2011 UR412 (SDO → TNO)
- 2013 GA137 (SDO → TNO)

Objects recently assigned numbers:

- 1999 ON4 = (439858)
- 2010 VZ98 = (445473)
- 2001 FO185 = (443843)
- 2004 EU95 = (444018)
- 2004 HJ79 = (444025)
- 2004 NT33 = (444030)
- 2007 JF43 = (444745)

Deleted/Re-identified objects:

- 2015 KB157 = 2013 LU28

Current number of TNOs: 1445 (including Pluto)
Current number of Centaurs/SDOs: 474
Current number of Neptune Trojans: 12

Out of a total of 1931 objects:

- 661 have measurements from only one opposition
- 638 of those have had no measurements for more than a year
- 329 of those have arcs shorter than 10 days

(for more details, see: [http://www.boulder.swri.edu/ekonews/objects/recov_stats.jpg](http://www.boulder.swri.edu/ekonews/objects/recov_stats.jpg))
PAPERS ACCEPTED TO JOURNALS

The Pluto System: Initial Results from its Exploration by New Horizons


1 Southwest Research Institute, Boulder, Colorado 80302, USA
2 University of Colorado, Laboratory for Atmospheric and Space Physics, Boulder, Colorado 80303, USA
3 NASA, Ames Research Center, Space Science Division, Moffett Field, California 94035, USA
4 SouthWest Research Institute, San Antonio, Texas 85204, USA
5 Lowell Observatory, Flagstaff, Arizona 86001, USA
6 Washington University in St. Louis, Department of Earth and Planetary Sciences, St. Louis, Missouri 63130, USA
7 Johns Hopkins University Applied Physics Laboratory, Laurel, Maryland 20723, USA
8 University of Munich, Munich 80539, Germany
9 Planetary Science Institute, Tucson, Arizona 85719, USA
10 KinetX Aerospace, Tempe, Arizona 85284, USA
11 NASA Jet Propulsion Laboratory, La Canada Flintridge, California 91011, USA
12 Massachusetts Institute of Technology, Cambridge, Massachusetts 02139, USA
13 University of Bonn, Bonn D-53113, Germany
14 National Aeronautics and Space Administration Headquarters (retired), Washington, D.C. 20546, USA
15 University of Arizona, Tucson, Arizona 85721, USA
The Pluto system was recently explored by NASA’s New Horizons spacecraft, making closest approach on 14 July 2015. Pluto’s surface displays diverse landforms, terrain ages, albedos, colors, and composition gradients. Evidence is found for a water-ice crust, geologically young surface units, surface ice convection, wind streaks, volatile transport, and glacial flow. Pluto’s atmosphere is highly extended, with trace hydrocarbons, a global haze layer, and a surface pressure near 10 microbars.

Pluto’s diverse surface geology and long term activity raise fundamental questions about how small planets remain active many billions of years (Gyr) after formation. Pluto’s large moon Charon displays tectonics and evidence for a heterogeneous crustal composition; its North Pole displays puzzling dark terrain. Small satellites Hydra and Nix have higher albedos than expected.

Published in: Science, 350, 292 (2015 Oct 16)
Available on the web at http://www.sciencemag.org/content/350/6258/aad1815

New Constraints on the Surface of Pluto

F. Merlin

Spectroscopic investigation of the surface of Pluto allows us to constrain the chemical properties of the volatile species of the solar system reservoir. This permits us to obtain the relative abundances of various molecules, their physical properties, as well as their spatial and temporal variation. This also could tell us about the origin of various minor chemical compounds formed during the solar system formation or generated later on by space weathering. This will give us critical information about the evolution processes that may occur in the entire trans-Neptunian objects population, and in particular the biggest objects, which could retain tenuous atmospheres.

New observations of the surface of Pluto have been carried out along with reanalyses of older observations carried out with the ESO-VLT telescopes and the SINFONI instrument at a mean spectral resolution of 1500. We present three new near-infrared spectra of Pluto observed at different
epochs, and covering the $H$ and $K$ spectral bands showing absorption features of methane, nitrogen, and carbon monoxide ices. We ran different spectral models, based on Hapke theory, to constrain the physical and chemical properties of different sides of Pluto.

We have confirmed the spatial and secular variation of the spectral properties of the surface of Pluto. The abundances, sizes, and temperatures of different ices, such as CH$_4$, CO, and N$_2$ have been constrained for different parts of the surface of Pluto. The results suggest a temperature probably just above the alpha-beta transition phase of N$_2$ (close to 36.5 K), and a probable stratification of the dilution state of CO and CH$_4$. The presence of minor chemical compounds, such as C$_2$H$_6$, has been confirmed too, and for data obtained at several sub-Earth east longitudes. Solid C$_2$H$_4$ is suggested by the spectral modeling with abundance variation following that of solid C$_2$H$_6$ and solid CH$_4$.

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For preprints, contact frederic.merlin@obspm.fr

Solar Wind at 33 AU: Setting Bounds on the Pluto Interaction for New Horizons

F. Bagenal$^1$, P.A. Delamere$^2$, H.A. Elliott$^3$, M.E. Hill$^4$, C.M. Lisse$^4$, D.J. McComas$^{3,7}$, R.L. McNutt, Jr.$^4$, J.D. Richardson$^5$, C.W. Smith$^6$, and D.F. Strobel$^8$

$^1$ University of Colorado, Boulder CO, USA
$^2$ University of Alaska, Fairbanks AK, USA
$^3$ Southwest Research Institute, San Antonio TX, USA
$^4$ Applied Physics Laboratory, The Johns Hopkins University, Laurel MD, USA
$^5$ Massachusetts Institute of Technology, Cambridge MA, USA
$^6$ University of New Hampshire, Durham NH, USA
$^7$ University of Texas at San Antonio, San Antonio TX, USA
$^8$ The Johns Hopkins University, Baltimore MD, USA

NASA’s New Horizons spacecraft flies past Pluto on July 14, 2015, carrying two instruments that detect charged particles. Pluto has a tenuous, extended atmosphere that is escaping the planet’s weak gravity. The interaction of the solar wind with Pluto’s escaping atmosphere depends on solar wind conditions as well as the vertical structure of Pluto’s atmosphere. We have analyzed Voyager 2 particles and fields measurements between 25 and 39 AU and present their statistical variations. We have adjusted these predictions to allow for the Sun’s declining activity and solar wind output. We summarize the range of SW conditions that can be expected at 33 AU and survey the range of scales of interaction that New Horizons might experience. Model estimates for the solar wind stand-off distance vary from $\sim7$ to $\sim1000 \, R_P$ with our best estimate being around 40 $R_P$ (where we take Pluto’s radius to be $R_P=1184$ km).

To appear in: Journal of Geophysical Research: Planets, v. 120
For preprints, contact bagenal@colorado.edu
and available on the web at http://arxiv.org/abs/1509.04660
Quaoar: Surface Composition Variability

M. A. Barucci¹, C. M. Dalle Ore², D. Perna¹, D. P. Cruikshank², A. Doressoundiram¹, A. Alvarez-Candal³, E. Dotto⁴, and C. Nitschelm⁵

¹ LESIA – Observatoire de Paris, PSL Research University, CNRS, Sorbonne Univ., UPMC Univ. Paris 06, Univ. Paris Diderot, Sorbonne Paris Cité, 92195 Meudon Principal Cedex, France
² NASA Ames Research Center, Mail Stop 245-6, Moffett Field, CA 94035, USA
³ Observatório Nacional, COAA, Rua General José Cristino 77, 20921-400, Rio de Janeiro, Brazil
⁴ INAF – Osservatorio Astronomico di Roma, 00040 Monte Porzio Catone (Roma), Italy
⁵ Universidad de Astronomía, Facultad de Ciencias Básicas, Universidad de Antofagasta, Avenida Angamos 601, Antofagasta, Chile
⁶ Carl Sagan Center, SETI Institute, 189 Bernardo Ave, Mountain View, CA 94043, USA

The goal of this work is to investigate the composition of the surface of (50000) Quaoar and its spatial variability.

We present new continuous spectra from visible to near-infrared (0.3-2.3 µm) obtained with the X-Shooter instrument at the VLT-ESO at four different epochs on the surface of Quaoar. The data, which, for this object, represent the highest spectral resolution data ever obtained and the first near-IR dataset acquired in a single exposure over the entire wavelength range, are complemented by previously published photometric observations obtained in the near-infrared (3.6, 4.5 µm) with the Spitzer Space Telescope, which provide an extra set of constraints in the model calculation. Spectral modeling was performed for the entire wavelength range by means of a code based on the Shkuratov radiative transfer formulation and using an updated value of albedo obtained from recent Herschel observations.

We obtain compositional information for different observed areas which can cover about 40% of the assumed rotational period of 8.84 hrs. Our analysis supports the presence of CH₄ and C₂H₆, as previously reported, along with indications of possible presence of NH₃·H₂O. New evidence for the presence of N₂ is inferred from the shift of the CH₄ bands. The albedo at the two Spitzer bands suggests, for one of the surface locations, the possible presence of CO diluted in N₂, and CO₂.

The spectral similarities indicate overall homogeneity of the surface composition of one hemisphere of Quaoar, while some subtle variations are apparent when modeling is performed. The presence of NH₃·H₂O would support the idea that Quaoar’s surface may be relatively young as previously suggested by Jewitt and Luu (2004).

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For preprints, contact antonella.barucci@obspm.fr

Rotationally Resolved Spectroscopy of Dwarf Planet (136472) Makemake

V. Lorenzi¹, N. Pinilla-Alonso², and J. Licandro³,⁴

¹ Fundación Galileo Galilei-INAF, Spain
² Department of Earth and Planetary Sciences, University of Tennessee, TN, USA
³ Instituto Astrofísico de Canarias, IAC, Spain
⁴ Departamento de Astrofísica, Universidad de La Laguna, Tenerife, Spain

Icy dwarf planets are key for studying the chemical and physical states of ices in the outer solar system. The study of secular and rotational variations gives us hints of the processes that contribute
to the evolution of their surface. The aim of this work is to search for rotational variability on the surface composition of the dwarf planet (136472) Makemake.

We observed Makemake in April 2008 with the medium-resolution spectrograph ISIS, at the William Herschel Telescope (La Palma, Spain) and obtained a set of spectra in the 0.28-0.52 μm and 0.70-0.95 μm ranges, covering 82% of its rotational period. For the rotational analysis, we organized the spectra in four different sets corresponding to different rotational phases, and after discarding one with low signal to noise, we analyzed three of them that cover 71% of the surface. For these spectra we computed the spectral slope and compared the observed spectral bands of methane ice with reflectances of pure methane ice to search for shifts of the center of the bands, related to the presence of CH₄/N₂ solid solution.

All the spectra have a red color with spectral slopes between 20%/1000 Å and 32%/1000 Å in accordance with previously reported values. Some variation in the spectral slope is detected, pointing to the possibility of a variation in the surface content or the particle size of the solid organic compound. The absorption bands of methane ice present a shift toward shorter wavelengths, indicating that methane (at least partially) is in solid solution with nitrogen. There is no variation within the errors of the shifts with the wavelength or with the depth of the bands, so there is no evidence of variation in the CH₄/N₂ mixing ratio with rotation. By comparing with all the available data in the literature, no secular compositional variations between 2005 and 2008 is found.

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A Digital Video System for Observing and Recording Occultations

M.A. (Tony) Barry¹, Dave Gault², Hristo Pavlov³, William Hanna¹, Alistair McEwan¹ and Miroslav D. Filipovic⁵

¹ Electrical and Information Engineering Department, University of Sydney, Camperdown, NSW 2006 Australia
² Kuriwa Observatory (MPC E28) 22 Booker Rd, Hawkesbury Heights, NSW 2777, Australia
³ Tangra Observatory (MPC E24) 9 Chad Place, St. Clair, NSW 2759, Australia
⁴ 190 Glenelges Trail, Columbia Falls, MT 59912-4390, USA
⁵ University of Western Sydney, Locked Bag 1797, Penrith South, NSW 1797 Australia

Stellar occultations by asteroids and outer solar system bodies can offer ground based observers with modest telescopes and camera equipment the opportunity to probe the shape, size, atmosphere, and attendant moons or rings of these distant objects. The essential requirements of the camera and recording equipment are: good quantum efficiency and low noise; minimal dead time between images; good horological faithfulness of the image timestamps; robustness of the recording to unexpected failure; and low cost. We describe an occultation observing and recording system which attempts to fulfill these requirements and compare the system with other reported camera and recorder systems. Five systems have been built, deployed, and tested over the past three years, and we report on three representative occultation observations: one being a 9±1.5 s occultation of the trans-Neptunian object 28978 Ixion (mᵥ = 15.2) at 3 seconds per frame; one being a 1.51±0.017 s occultation of Deimos, the 12 km diameter satellite of Mars, at 30 frames per second; and one being a 11.04±0.4 s occultation, recorded at 7.5 frames per second, of the main belt asteroid 361 Havnia, representing a low magnitude drop (∆mᵥ ~ 0.4) occultation.

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JWST Observations of Stellar Occultations by Solar System Bodies and Rings

P. Santos-Sanz\textsuperscript{1}, R.G. French\textsuperscript{2}, N. Pinilla-Alonso\textsuperscript{3}, J. Stansberry\textsuperscript{4}, Z-Y. Lin\textsuperscript{5}, Z-W. Zhang\textsuperscript{6}, E. Vilenius\textsuperscript{7,8}, Th. Müller\textsuperscript{7}, J.L. Ortiz\textsuperscript{1}, F. Braga-Ribas\textsuperscript{9}, A. Bosh\textsuperscript{10}, R. Duffard\textsuperscript{1}, E. Lellouch\textsuperscript{11}, G. Tancredi\textsuperscript{12}, L. Young\textsuperscript{13}, and the JWST ‘occultations’ focus group

\textsuperscript{1} Instituto de Astrofísica de Andalucía, IAA-CSIC, Glorieta de la Astronomía s/n, 18008 Granada, Spain
\textsuperscript{2} Department of Astronomy, Wellesley College, Wellesley, MA 02481, USA
\textsuperscript{3} Department of Earth and Planetary Sciences, University of Tennessee, Knoxville, 37996 TN, USA
\textsuperscript{4} Space Telescope Science Institute, 3700 San Martin Drive, Baltimore, MD 21218, USA
\textsuperscript{5} Institute of Astronomy, National Central University, Jhongli District, Taoyuan City 32001, Taiwan
\textsuperscript{6} Institute of Astronomy and Astrophysics, Academia Sinica, P.O. Box 23-141, Taipei 10617, Taiwan
\textsuperscript{7} Max Planck Institute for extraterrestrial Physics, Garching, Germany
\textsuperscript{8} Max Planck Institute for Solar System Research, Göttingen, Germany
\textsuperscript{9} Federal University of Technology - Paran (UTFPR / DAFIS), Curitiba, Brazil
\textsuperscript{10} Department of Earth, Atmospheric, and Planetary Sciences, MIT, Cambridge, MA, USA
\textsuperscript{11} LESIA-Observatoire de Paris, CNRS, UPMC Univ. Paris 6, Univ. Paris-Diderot, Meudon, France
\textsuperscript{12} Departamento de Astronomía, Facultad de Ciencias, Montevideo, Uruguay
\textsuperscript{13} SwRI, 1050 Walnut St., Boulder, CO 80302-5150, USA

In this paper we investigate the opportunities provided by the James Webb Space Telescope (JWST) for significant scientific advances in the study of solar system bodies and rings using stellar occultations. The strengths and weaknesses of the stellar occultation technique are evaluated in light of JWST’s unique capabilities. We identify several possible JWST occultation events by minor bodies and rings, and evaluate their potential scientific value. These predictions depend critically on accurate a priori knowledge of the orbit of JWST near the Sun-Earth Lagrange-point 2 (L2). We also explore the possibility of serendipitous stellar occultations by very small minor bodies as a by-product of other JWST observing programs. Finally, to optimize the potential scientific return of stellar occultation observations, we identify several characteristics of JWST’s orbit and instrumentation that should be taken into account during JWST’s development.


For preprints, contact psantos@iaa.es
The Spectrum of Pluto, 0.40-0.93 μm I. Secular and Longitudinal Distribution of Ices and Complex Organics

V. Lorenzi¹, N. Pinilla-Alonso², J. Licandro³,⁴, D.P. Cruikshank⁵, W.M. Grundy⁶, R.P. Binzel⁷, and J.P. Emery²

¹ Fundación Galileo Galilei-INAF, Spain
² Department of Earth and Planetary Sciences, University of Tennessee, TN, USA
³ Instituto Astrofísico de Canarias, IAC, Spain
⁴ Departamento de Astrofísica, Universidad de La Laguna, Tenerife, Spain
⁵ NASA Ames Research Center, CA, USA
⁶ Lowell Observatory, AZ, USA
⁷ Massachusetts Institute of Technology, MA, USA

During the last 30 years the surface of Pluto has been characterized, and its variability has been monitored, through continuous near-infrared spectroscopic observations. But in the visible range only few data are available. The aim of this work is to define the Pluto’s relative reflectance in the visible range to characterize the different components of its surface, and to provide ground based observations in support of the New Horizons mission. We observed Pluto on six nights between May and July 2014, with the imager/spectrograph ACAM at the William Herschel Telescope (La Palma, Spain). The six spectra obtained cover a whole rotation of Pluto (P_{rot} = 6.4 days). For all the spectra we computed the spectral slope and the depth of the absorption bands of methane ice between 0.62 and 0.90 μm. To search for shifts of the center of the methane bands, associated with dilution of CH₄ in N₂, we compared the bands with reflectances of pure methane ice. All the new spectra show the methane ice absorption bands between 0.62 and 0.90 μm. The computation of the depth of the band at 0.62 μm in the new spectra of Pluto, and in the spectra of Makemake and Eris from the literature, allowed us to estimate the Lambert coefficient at this wavelength, at a temperature of 30 K and 40 K, never measured before. All the detected bands are blue shifted with respect to the position for pure methane ice, with minimum shifts in correspondence with the regions where the abundance of methane is higher. This could be indicative of a dilution of CH₄:N₂ more saturated in CH₄. The longitudinal and secular variations of the parameters measured in the spectra are in accordance with results previously reported in the literature and with the distribution of the dark and bright material that show the Pluto’s albedo maps from New Horizons.

Submitted to: Astronomy & Astrophysics
Forming the Cold Classical Kuiper Belt in a Light Disk

Andrew Shannon\textsuperscript{1,3}, Yanqin Wu\textsuperscript{1} and Yoram Lithwick\textsuperscript{2}

\textsuperscript{1}Department of Astronomy and Astrophysics, University of Toronto, Toronto, ON M5S 3H4, Canada
\textsuperscript{2}Department of Physics and Astronomy, Northwestern University, Evanston, IL 60208 and Center for Interdisciplinary Exploration and Research in Astrophysics (CIERA), USA
\textsuperscript{3}Institute of Astronomy, University of Cambridge, Madingley Road, Cambridge CB3 0HA, UK

Large Kuiper Belt Objects are conventionally thought to have formed out of a massive planetesimal belt that is a few thousand times its current mass. Such a picture, however, is incompatible with multiple lines of evidence. Here, we present a new model for the conglomeration of Cold Classical Kuiper belt objects, out of a solid belt only a few times its current mass, or a few percent of the solid density in a Minimum Mass Solar Nebula. This is made possible by depositing most of the primordial mass in grains of size centimetre or smaller. These grains collide frequently and maintain a dynamically cold belt out of which large bodies grow efficiently: an order-unity fraction of the solid mass can be converted into large bodies, in contrast to the $\sim 10^{-3}$ efficiency in conventional models. Such a light belt may represent the true outer edge of the Solar system, and it may have effectively halted the outward migration of Neptune. In addition to the high efficiency, our model can also produce a mass spectrum that peaks at an intermediate size, similar to the observed Cold Classicals, if one includes the effect of cratering collisions. In particular, the observed power-law break observed at $\sim 30$ km for Cold Classicals, one that has been interpreted as a result of collisional erosion, may be primordial in origin.

Submitted to: The Astrophysical Journal

For preprints, contact shannon@ast.cam.ac.uk
or on the web at http://arxiv.org/abs/1510.01323

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JOB ANNOUNCEMENTS

Post-Doc Positions in Brazil

The Group of Orbital Dynamics & Planetology invites applications for post-doc positions. There are 4 positions that will be funded by FAPESP (Fundação de Amparo à Pesquisa do Estado de São Paulo). The candidates must have experience on Planetary Dynamics and/or Spacecraft Dynamics.

The projects to be developed are the following:
Spin-orbit coupling in solar system dynamics;
Problems in orbital dynamics involving small bodies under gravitational close approaches;
Dynamics of narrow planetary rings and small satellites;
Attitude and orbit analysis for a mission to a triple asteroid system;

The projects will be developed in one of the following institutions: I) São Paulo State University - UNESP in Guaratinguetá; II) National Institute for Space Research - INPE in São José dos Campos. Applicants should send a statement of research interest and a curriculum vitae with a list of publications to: Prof. Othon Winter (email: ocwinter@gmail.com)
The Distant EKOs Newsletter is dedicated to provide researchers with easy and rapid access to current work regarding the Kuiper belt (observational and theoretical studies), directly related objects (e.g., Pluto, Centaurs), and other areas of study when explicitly applied to the Kuiper belt.

We accept submissions for the following sections:

- Abstracts of papers submitted, in press, or recently published in refereed journals
- Titles of conference presentations
- Thesis abstracts
- Short articles, announcements, or editorials
- Status reports of on-going programs
- Requests for collaboration or observing coordination
- Table of contents/outlines of books
- Announcements for conferences
- Job advertisements
- General news items deemed of interest to the Kuiper belt community

A \LaTeX template for submissions is appended to each issue of the newsletter, and is sent out regularly to the e-mail distribution list. Please use that template, and send your submission to:

ekonews@boulder.swri.edu

The Distant EKOs Newsletter is available on the World Wide Web at:

http://www.boulder.swri.edu/ekonews

Recent and back issues of the newsletter are archived there in various formats. The web pages also contain other related information and links.

Distant EKOs is not a refereed publication, but is a tool for furthering communication among people interested in Kuiper belt research. Publication or listing of an article in the newsletter or the web page does not constitute an endorsement of the article’s results or imply validity of its contents. When referencing an article, please reference the original source; Distant EKOs is not a substitute for peer-reviewed journals.

Moving ... ??

If you move or your e-mail address changes, please send the editor your new address. If the newsletter bounces back from an address for three consecutive issues, the address will be deleted from the mailing list. All address changes, submissions, and other correspondence should be sent to:

ekonews@boulder.swri.edu