*Issue No. 92* *April 2014*

# *DISTANT EKOs*

*The Kuiper Belt Electronic Newsletter*

*Edited by: Joel Wm. Parker*

ekonews@boulder.swri.edu www.boulder.swri.edu/ekonews

## CONTENTS

# NEWS & ANNOUNCEMENTS

There were 3 new TNO discoveries announced since the previous issue of *Distant EKOs*:

2011 HJ103, 2012 HZ84, 2012 XR157

and 10 new Centaur/SDO discoveries:

2011 HK103, 2012 VP113, 2013 FY27, 2013 FZ27, 2013 LU35, 2014 DT112, 2014 FW, 2014 FX43, 2014 GE45, 2014 HY123

Reclassified objects:

2010 GF65 (SDO → Centaur)
2012 GX17 (Centaur → SDO)
2014 FW (Centaur → SDO)
2013 FZ27 (SDO → TNO)

Objects recently assigned numbers:

2011 WU92 = (389820)

Objects recently assigned names:

2003 QW111 = Manwe

Current number of TNOs: 1263 (including Pluto)
Current number of Centaurs/SDOs: 393
Current number of Neptune Trojans: 9

Out of a total of 1665 objects:

644 have measurements from only one opposition
631 of those have had no measurements for more than a year
326 of those have arcs shorter than 10 days

(for more details, see: `http://www.boulder.swri.edu/ekonews/objects/recov_stats.jpg`)

# PAPERS ACCEPTED TO JOURNALS

## A Sedna-like Body with a Perihelion of 80 Astronomical Units

**C. Trujillo[1] and S. Sheppard[2]**

[1] Gemini Observatory, 670 North A'ohoku Place, Hilo, HI 96720, USA

[2] Carnegie Institution for Science, 5241 Broad Branch Road NW, Washington, DC 20015, USA

The observable Solar System can be divided into three distinct regions: the rocky terrestrial planets including the asteroids at 0.39 to 4.2 astronomical units (AU) from the Sun (where 1 AU is the mean distance between Earth and the Sun), the gas giant planets at 5 to 30 AU from the Sun, and the icy Kuiper belt objects at 30 to 50 AU from the Sun. The 1,000-kilometre-diameter dwarf planet Sedna was discovered ten years ago and was unique in that its closest approach to the Sun (perihelion) is 76 AU, far greater than that of any other Solar System body. Formation models indicate that Sedna could be a link between the Kuiper belt objects and the hypothesized outer Oort cloud at around 10,000 AU from the Sun. Here we report the presence of a second Sedna-like object, 2012 VP113, whose perihelion is 80 AU. The detection of 2012 VP113 confirms that Sedna is not an isolated object; instead, both bodies may be members of the inner Oort cloud, whose objects could outnumber all other dynamically stable populations in the Solar System.

**Published in: Nature 507, 471 (2014 March 27)**

*For preprints, contact* `trujillo@gemini.edu`

. . . . . .

## Ejecta Transfer in the Pluto System

**S.B. Porter[1,2] and W.M. Grundy[1]**

[1] Lowell Observatory, 1400 W Mars Hill Rd, Flagstaff, AZ 86001, USA

[2] Now at Southwest Research Institute, 1050 Walnut St, Suite 300, Boulder, CO 80302, USA

The small satellites of the Pluto system (Styx, Nix, Kerberos, and Hydra) have very low surface escape velocities, and impacts should therefore eject a large amount of material from their surfaces. We show that most of this material then escapes from the Pluto system, though a significant fraction collects on the surfaces of Pluto and Charon. The velocity at which the dust is ejected from the surfaces of the small satellites strongly determines which object it is likely to hit, and where on the surfaces of Pluto and Charon it is most likely to impact. We also show that the presence of an atmosphere around Pluto eliminates most particle size effects and increases the number of dust impacts on Pluto. In total, Pluto and Charon may have accumulated several centimeters of small-satellite dust on their surfaces, which could be observed by the New Horizons spacecraft.

**Published in: Icarus (Pluto special issue)**

*Preprints available on the web at* `http://arxiv.org/abs/1403.4873`

. . . . . .

# A Ring System Detected around the Centaur (10199) Chariklo

**F. Braga-Ribas[1], B. Sicardy[2], J.L. Ortiz[3], C. Snodgrass[4], F. Roques[2], R. Vieira-Martins[1,5,6], J.I.B. Camargo[1], M. Assafin[5], R. Duffard[3], E. Jehin[7], J. Pollock[8], R. Leiva[9], M. Emilio[10], D. I. Machado[11,12], C. Colazo[13,14], E. Lellouch[2], J. Skottfelt[15,16], M. Gillon[7], N. Ligier[2], L. Maquet[2], G. Benedetti-Rossi[1], A. Ramos Gomes Jr[5], P. Kervella[2], H. Monteiro[17], R. Sfair[18], M. El Moutamid[2,6], G. Tancredi[19,20], J. Spagnotto[21], A. Maury[22], N. Morales[3], R. Gil-Hutton[23], S. Roland[19], A. Ceretta[20,24], S.-h. Gu[25,26], X.-b. Wang[25,26], K. Harpsøe[15,16], M. Rabus[9,27], J. Manfroid[7], C. Opitom[7], L. Vanzi[28], L. Mehret[10], L. Lorenzini[11], E.M. Schneiter[14,29,30,31], R. Melia[14], J. Lecacheux[2], F. Colas[6], F. Vachier[6], T. Widemann[2], L. Almenares[19,20], R.G. Sandness[22], F. Char[32], V. Perez[19,20], P. Lemos[20], N. Martinez[19,20], U.G. Jørgensen[15,16], M. Dominik[33,†], F. Roig[1], D.E. Reichart[34], A.P. LaCluyze[34], J.B. Haislip[34], K.M. Ivarsen[34], J.P. Moore[34], N.R. Frank[34], and D.G. Lambas[14,30]**

[1] Observatório Nacional/MCTI, Rua General José Cristino 77, CEP 20921–400 Rio de Janeiro, RJ, Brazil

[2] LESIA, Observatoire de Paris, CNRS UMR 8109, Univ. Pierre et Marie Curie, Univ. Paris–Diderot, 5 place Jules Janssen, F–92195 MEUDON Cedex, France

[3] Instituto de Astrofísica de Andalucía, CSIC , Apt. 3004, 18080 Granada, Spain

[4] Max Planck Institute for Solar System Research, Justus-von-Liebig-Weg 3, 37077 Göttingen, Germany

[5] Observatório do Valongo/UFRJ, Ladeira Pedro Antonio 43, CEP 20.080–090 Rio de Janeiro, RJ, Brazil

[6] Observatoire de Paris, IMCCE, UPMC, CNRS, 77 Av. Denfert–Rochereau, 75014 Paris, France

[7] Institut d'Astrophysique de l'Université de Liège, Allée du 6 Août 17, B–4000 Liège, Belgium

[8] Physics and Astronomy Department, Appalachian State Univ., Boone, NC 28608, USA

[9] Instituto de Astrofísica, Facultad de Física, Pontificia Universidad Católica de Chile, Av. Vicuña Mackenna 4860, Santiago, Chile

[10] Universidade Estadual de Ponta Grossa, O.A. – DEGEO, Av. Carlos Cavalcanti 4748, Ponta Grossa 84030-900, PR, Brazil

[11] Polo Astronômico Casimiro Montenegro Filho / FPTI–BR, Av. Tancredo Neves, 6731, CEP 85867–900, Foz do Iguaçu, PR, Brazil

[12] Universidade Estadual do Oeste do Paraná (Unioeste), Av. Tarquínio Joslin dos Santos, 1300, CEP 85870-650, Foz do Iguaçu, PR, Brazil

[13] Ministerio de Educación de la Provincia de Córdoba, Córdoba, Argentina

[14] Observatorio Astronómico, Universidad Nacional de Córdoba, Córdoba, Argentina

[15] Niels Bohr Institute, University of Copenhagen, Juliane Maries vej 30, 2100 Copenhagen, Denmark

[16] Centre for Star and Planet Formation, Geological Museum, Øster Voldgade 5, 1350 Copenhagen, Denmark

[17] Instituto de Física e Química, Av. BPS 1303, CEP 37500-903, Itajubá, MG, Brazil

[18] UNESP – Univ Estadual Paulista, Av Ariberto Pereira da Cunha, 333, CEP 12516-410 Guaratinguetá, SP, Brazil

[19] Observatorio Astronomico Los Molinos, DICYT, MEC, Montevideo, Uruguay

[20] Dpto. Astronomia, Facultad Ciencias, Uruguay

[21] Observatorio El Catalejo, Santa Rosa, La Pampa, Argentina

[22] San Pedro de Atacama Celestial Explorations, Casilla 21, San Pedro de Atacama, Chile

[23] Complejo Astronómico El Leoncito (CASLEO) and San Juan National University, Av. España 1512 sur, J5402DSP, San Juan, Argentina

[24] Observatorio del IPA, Consejo de Formación en Educación, Uruguay

[25] Yunnan Observatories, Chinese Academy of Sciences, Kunming 650011, China

[26] Key Laboratory for the Structure and Evolution of Celestial Objects, Chinese Academy of Sciences, Kunming, China

[27] Max Planck Institute for Astronomy, Königstuhl 17, 69117, Heidelberg, Germany

[28] Department of Electrical Engineering and Center of Astro–Engineering, Pontificia Universidad Católica de Chile,

Av. Vicuña Mackenna 4860, Santiago, Chile
[29] Consejo Nacional de Investigaciones Científicas y Técnicas (CONICET), Argentina
[30] Instituto de Astronomía Teórica y Experimental IATE-CONICET, Córdoba, Argentina
[31] Facultad de Ciências Exactas, Físicas y Naturales, Universidad Nacional de Córdoba (UNC), Córdoba, Argentina
[32] Unidad de Astronomía, Facultad de Ciencias Básicas, Universidad de Antofagasta, Avenida Angamos 601, Antofagasta, Chile
[33] SUPA, University of St Andrews, School of Physics & Astronomy, North Haugh, St Andrews, KY16 9SS, United Kingdom. [†]Royal Society University Research Fellow
[34] Department of Physics and Astronomy, University of North Carolina – Chapel Hill, North Carolina, USA

Hitherto, rings have been found exclusively around the four giant planets in the Solar System. Rings are natural laboratories in which to study dynamical processes analogous to those that take place during the formation of planetary systems and galaxies. Their presence also tells us about the origin and evolution of the body they encircle. Here we report observations of a multichord stellar occultation that revealed the presence of a ring system around (10199) Chariklo, which is a Centaur — that is, one of a class of small objects orbiting primarily between Jupiter and Neptune — with an equivalent radius of 124±9 km. There are two dense rings, with respective widths of about 7 and 3 km, optical depths of 0.4 and 0.06, and orbital radii of 391 and 405 km. The present orientation of the ring is consistent with an edge-on geometry in 2008, which provides a simple explanation for the dimming of the Chariklo system between 1997 and 2008, and for the gradual disappearance of ice and other absorption features in its spectrum over the same period. This implies that the rings are partly composed of water ice. They may be the remnants of a debris disk, possibly confined by embedded, kilometre-sized satellites.

This paper contains Supplementary Information.

**Published in: Nature, 508, 72 (2014 April 3)**
*For preprints, contact* ribas@on.br
*or on the web at* www.nature.com/nature/journal/v508/n7494/full/nature13155.html

.....

## Exploring the Spatial, Temporal, and Vertical Distribution of Methane in Pluto's Atmosphere

**E. Lellouch[1], C. de Bergh[1], B. Sicardy[1], F. Forget[2], M. Vangvichith[2], and H.-U. Käufl[3]**
[1] Laboratoire d'Etudes Spatiales et d'Instrumentation en Astrophysique (LESIA), Observatoire de Paris, France
[2] Laboratoire de Météorologie Dynamique, Université Paris-6, France
[3] European Southern Observatory (ESO), Garching, Germany

High-resolution spectra of Pluto in the 1.66 $\mu$m region, recorded with the VLT/CRIRES instrument in 2008 (2 spectra) and 2012 (5 spectra), are analyzed to constrain the spatial and vertical distribution of methane in Pluto's atmosphere and to search for mid-term (4 year) variability. A sensitivity study to model assumptions (temperature structure, surface pressure, Pluto's radius) is performed. Results indicate that (i) no variation of the $CH_4$ atmospheric content (column-density or mixing ratio) with Pluto rotational phase is present in excess of 20% (ii) $CH_4$ column densities show at most marginal variations between 2008 and 2012, with a best guess estimate of a $\sim$20% decrease over this time frame. As stellar occultations indicate that Pluto's surface pressure has continued to increase over this period, this implies a concomitant decrease of the methane mixing ratio (iii) the data do not show evidence for an altitude-varying methane distribution; in particular, they imply a roughly uniform mixing ratio in at least the first 22–27 km of the atmosphere, and high concentrations of low-temperature methane near the surface can be ruled out. Our results are

also best consistent with a relatively large (>1180 km) Pluto radius. Comparison with predictions from a recently developed global climate model indicates that these features are best explained if the source of methane occurs in regional-scale $CH_4$ ice deposits, including both low latitudes and high Northern latitudes, evidence for which is present from the rotational and secular evolution of the near-IR features due to $CH_4$ ice. Our "best guess" predictions for the New Horizons encounter in 2015 are: a 1184 km radius, a 17 $\mu$bar surface pressure, and a 0.44% $CH_4$ mixing ratio with negligible longitudinal variations.

**To appear in: Icarus (Pluto special issue)**
*Preprints available on the web at* `http://arxiv.org/abs/1403.3208`

. . . . . .

## Evidence that Pluto's Atmosphere Does not Collapse from Occultations Including the 2013 May 04 Event

**C.B. Olkin[1], L.A. Young[1], D. Borncamp[1], A. Pickles[2], B. Sicardy[3], M. Assafin[4], F.B. Bianco[5], M.W. Buie[1], A. Dias de Oliveira[3,10], M. Gillon[6], R.G. French[7], A. Ramos Gomes Jr.[4], E. Jehin[6], N. Morales[8], C. Opitom[6], J.L. Ortiz[8], A. Maury[9], M. Norbury[2], F. Braga-Ribas[10], R. Smith[11], L.H. Wasserman[12], E.F. Young[1], M. Zacharias[13], and N. Zacharias[13]**

[1] Southwest Research Institute, Boulder 80503, USA
[2] Las Cumbres Observatory Global Telescope Network, Goleta 93117, USA
[3] Observatoire de Paris, Meudon, France
[4] Universidade Federal do Rio de Janeiro, Observatorio do Valongo, Rio de Janeiro, Brazil
[5] Center for Cosmology and Particle Physics, New York University, NY 10003, USA
[6] Institut d'Astrophysique de l'Université de Liège, Liège, Belgium
[7] Wellesley College, Wellesley, 02481, USA
[8] Instituto de Astrofísica de Andalucía-CSIC, Granada, Spain
[9] San Pedro de Atacama Celestial Explorations (S.P.A.C.E.), San Pedro de Atacama, Chile
[10] Observatório Nacional/MCTI, Rio de Janeiro, Brazil
[11] Astrophysics Research Institute, Liverpool John Moores University, Liverpool, UK
[12] Lowell Observatory, Flagstaff 86001, USA
[13] United States Naval Observatory, Washington, DC 20392, USA

Combining stellar occultation observations probing Pluto's atmosphere from 1988 to 2013, and models of energy balance between Pluto's surface and atmosphere, we find the preferred models are consistent with Pluto retaining a collisional atmosphere throughout its 248-year orbit. The occultation results show an increasing atmospheric pressure with time in the current epoch, a trend present only in models with a high thermal inertia and a permanent $N_2$ ice cap at Pluto's north rotational pole.

**To appear in: Icarus**
*For preprints, contact* `colkin@boulder.swri.edu`
*or on the web at* `http://arxiv.org/abs/1309.0841`

. . . . . .

## Will New Horizons see Dust Clumps in the Edgeworth-Kuiper Belt?

**Ch. Vitense[1], A. V. Krivov[1], and T. Löhne[1]**

[1] Astrophysikalisches Institut, Friedrich-Schiller-Universität Jena, Schillergäßchen 2–3, 07745 Jena, Germany

Debris disks are thought to be sculptured by neighboring planets. The same is true for the Edgeworth-Kuiper debris disk, yet no direct observational evidence for signatures of giant planets in the Kuiper belt dust distribution has been found so far. Here we model the dust distribution in the outer solar system to reproduce the dust impact rates onto the dust detector onboard the New Horizons spacecraft measured so far and to predict the rates during the Neptune orbit traverse. To this end, we take a realistic distribution of transneptunian objects to launch a sufficient number of dust grains of different sizes and follow their orbits by including radiation pressure, Poynting-Robertson and stellar wind drag, as well as the perturbations of four giant planets. In a subsequent statistical analysis, we calculate number densities and lifetimes of the dust grains in order to simulate a collisional cascade. In contrast to the previous work, our model not only considers collisional elimination of particles, but also includes production of finer debris. We find that particles captured in the 3:2 resonance with Neptune build clumps that are not removed by collisions, because the depleting effect of collisions is counteracted by production of smaller fragments. Our model successfully reproduces the dust impact rates measured by New Horizons out to $\approx 23$ AU and predicts an increase of the impact rate of about a factor of two or three around the Neptune orbit crossing. This result is robust with respect to the variation of the vaguely known number of dust-producing scattered disk objects, collisional outcomes, and the dust properties.

**To appear in: The Astronomical Journal**

*For preprints, contact* `vitense@astro.uni-jena.de`

. . . . . .

## The Orbit of Transneptunian Binary Manwë and Thorondor and their Upcoming Mutual Events

**W.M. Grundy[1], S.D. Benecchi[2], S.B. Porter[3], and K.S. Noll[4]**

[1] Lowell Observatory, 1400 W. Mars Hill Rd., Flagstaff AZ 86001, USA

[2] Planetary Science Institute, 1700 E. Fort Lowell Suite 106, Tucson AZ 85719, USA

[3] Southwest Research Institute, 1050 Walnut St. #300, Boulder CO 80302, USA

[4] NASA Goddard Space Flight Center, Greenbelt MD 20771, USA

A new Hubble Space Telescope observation of the 7:4 resonant transneptunian binary system (385446) Manwë has shown that, of two previously reported solutions for the orbit of its satellite Thorondor, the prograde one is correct. The orbit has a period of 110.18±0.02 days, semimajor axis of 6670±40 km, and an eccentricity of 0.563±0.007. It will be viewable edge-on from the inner solar system during 2015–2017, presenting opportunities to observe mutual occultation and eclipse events. However, the number of observable events will be small, owing to the long orbital period and expected small sizes of the bodies relative to their separation. This paper presents predictions for events observable from Earth-based telescopes and discusses the associated uncertainties and challenges.

**To appear in: Icarus**

*Preprints available at*

`http://www2.lowell.edu/users/grundy/abstracts/2014.Manwe-Thorondor.html`

. . . . . .

# The Rotational Light Curve of (79360) Sila-Nunam, an Eclipsing Binary in the Kuiper Belt

**David L. Rabinowitz[1], Susan D. Benecchi[2], William M. Grundy[3], and Anne J. Verbiscer[4]**

[1] Yale University, USA

[2] Planetary Science Institute, USA

[3] Lowell Observatory, USA

[4] University of Virginia, USA

We combine long-term photometric observations in multiple band passes to determine the rotational light curve for the binary Kuiper-Belt object (79360) Sila-Nunam. We measure an unambiguous fundamental period of $6.2562 \pm 0.002$ d, within 0.02% of half the orbital period ($P_{orb} = 12.50995 \pm 0.00036$ d) determined earlier from HST observations resolving the binary. The light curve is double-peaked, and well fit by the sum of two sinusoids: a primary with period $P_{orb}/2$ and peak-to-peak amplitude $0.120 \pm 0.012$ mag and a secondary with period $P_{orb}$ and peak- to-peak amplitude $0.044 \pm 0.010$ mag. Excluding observations within $\sim$0.1 deg of opposition, we measure a linear solar phase dependence with slope $0.147 \pm 0.018$ mag deg$^{-1}$ and a mean absolute magnitude in the Gunn $g$ band of $6.100 \pm 0.006$ mag. There is no rotational color variation exceeding 4%. We also observe that eclipses occur centered on light curve minima to within 0.3%, requiring the long axis of at least one of the two bodies to point precisely toward the other. Assuming the binary is doubly synchronous and both rotation axes are aligned with the orbital angular momentum vector, our observations jointly constrain triaxial shape models for Sila and Nunam such that the product of their long-to-intermediate axes ratios is $1.120 \pm 0.01$. Hence both bodies are elongated by 6%, or else one is elongated by 6% to 12%, and the other by less than 6%.

**To appear in: Icarus**

*Preprints available on the web at* `http://arxiv.org/abs/1404.0244`

. . . . . .

# "TNOs are Cool": A Survey of the Trans-Neptunian Region X. Analysis of Classical Kuiper Belt Objects from *Herschel* and *Spitzer* Observations

**E. Vilenius[1], C. Kiss[2], T. Müller[1], M. Mommert[3,4], P. Santos-Sanz[5,6], A. Pál[2], J. Stansberry[7], M. Mueller[8,9], N. Peixinho[10,11], E. Lellouch[6], S. Fornasier[6,12], A. Delsanti[6,13], A. Thirouin[5], J. L. Ortiz[5], R. Duffard[5], D. Perna[6], and F. Henry[6]**

[1] Max-Planck-Institut für extraterrestrische Physik, Postfach 1312, Giessenbachstr., 85741 Garching, Germany

[2] Konkoly Observatory, Research Centre for Astronomy and Earth Sciences, Konkoly Thege 15-17, 1121 Budapest, Hungary

[3] Deutsches Zentrum für Luft- und Raumfahrt e.V., Institute of Planetary Research, Rutherfordstr. 2, 12489 Berlin, Germany

[4] Northern Arizona University, Department of Physics and Astronomy, PO Box 6010, Flagstaff, AZ 86011, USA

[5] Instituto de Astrofísica de Andalucía (CSIC), Glorieta de la Astronomía s/n, 18008-Granada, Spain

[6] LESIA-Observatoire de Paris, CNRS, UPMC Univ. Paris 06, Univ. Paris-Diderot, France

[7] Stewart Observatory, The University of Arizona, Tucson AZ 85721, USA

[8] SRON Netherlands Institute for Space Research, Postbus 800, 9700 AV Groningen, the Netherlands

[9] UNS-CNRS-Observatoire de la Côte d'Azur, Laboratoire Cassiopeé, BP 4229, 06304 Nice Cedex 04, France

[10] Center for Geophysics of the University of Coimbra, Geophysical and Astronomical Observatory of the University

of Coimbra, Almas de Freire, 3040-004 Coimbra, Portugal
[11] Unidad de Astronomía, Facultad de Ciencias Básicas, Universidad de Antofagasta, 601 Avenida Angamos, Antofagasta, Chile
[12] Univ. Paris Diderot, Sorbonne Paris Cité, 4 rue Elsa Morante, 75205 Paris, France
[13] Laboratoire d'Astrophysique de Marseille, CNRS & Université de Provence, 38 rue Frédéric Joliot-Curie, 13388 Marseille Cedex 13, France

The Kuiper belt is formed of planetesimals which failed to grow to planets and its dynamical structure has been affected by Neptune. The classical Kuiper belt contains objects both from a low-inclination, presumably primordial, distribution and from a high-inclination dynamically excited population. Based on a sample of classical TNOs with observations at thermal wavelengths we determine radiometric sizes, geometric albedos and thermal beaming factors for each object as well as study sample properties of dynamically hot and cold classicals. Observations near the thermal peak of TNOs using infra-red space telescopes are combined with optical magnitudes using the radiometric technique with near-Earth asteroid thermal model (NEATM). We have determined three-band flux densities from *Herschel*/PACS observations at 70.0, 100.0 and 160.0 $\mu$m and *Spitzer*/MIPS at 23.68 and 71.42 $\mu$m when available. We use reexamined absolute visual magnitudes from the literature and ground based programs in support of *Herschel* observations. We have analysed 18 classical TNOs with previously unpublished data and re-analysed previously published targets with updated data reduction to determine their sizes and geometric albedos as well as beaming factors when data quality allows. We have combined these samples with classical TNOs with radiometric results in the literature for the analysis of sample properties of a total of 44 objects. We find a median geometric albedo for cold classical TNOs of $0.14^{+0.09}_{-0.07}$ and for dynamically hot classical TNOs, excluding the Haumea family and dwarf planets, $0.085^{+0.084}_{-0.045}$. We have determined the bulk densities of Borasisi-Pabu ($2.1^{+2.6}_{-1.2}$ g cm$^{-3}$), Varda-Ilmarë ($1.25^{+0.40}_{-0.43}$ g cm$^{-3}$) and 2001 QC$_{298}$ ($1.14^{+0.34}_{-0.30}$ g cm$^{-3}$) as well as updated previous density estimates of four targets. We have determined the slope parameter of the debiased cumulative size distribution of dynamically hot classical TNOs as $q = 2.3 \pm 0.1$ in the diameter range $100 < D < 500$ km. For dynamically cold classical TNOs we determine $q = 5.1 \pm 1.1$ in the diameter range $160 < D < 280$ km as the cold classical TNOs have a smaller maximum size.

**Published in: Astronomy and Astrophysics, 564, A35**
*For preprints, contact* vilenius@mpe.mpg.de
*or on the web at* http://arxiv.org/abs/1403.6309

# PAPERS RECENTLY SUBMITTED TO JOURNALS

## Planet X Revamped after the Discovery of the Sedna-like Object 2012 $VP_{113}$?

**L. Iorio**[1]

[1] Ministero dell'Istruzione, dell'Università e della Ricerca (M.I.U. R.). Permanent address for correspondence: Viale Unità di Italia 68, 70125, Bari (BA), Italy

Submitted to:
*Preprints available on the web at* `http://arxiv.org/abs/1404.0258`

. . . . . .

## The Secular Evolution of the Kuiper Belt after a Close Stellar Encounter

**D. Punzo**[1,2], **R. Capuzzo-Dolcetta**[1], **and S. Portegies Zwart**[3]

[1] Dep. of Physics, Sapienza, University of Roma, P.le A. Moro 1, Roma, Italy
[2] Kapteyn Institute, Rijksuniversiteit, Landleven 12, 9747AD Groningen, Netherlands
[3] Leiden Observatory, Leiden University, P.O. Box 9513, 2300 RA Leiden, The Netherlands

Submitted to: Monthly Notices of the Royal Astronomical Society
*Preprint available on the web at* `http://arxiv.org/abs/1403.6633`

. . . . . .

## *WFIRST* Ultra-Precise Astrometry I: Kuiper Belt Objects

**Andrew Gould**[1]

[1] Department of Astronomy, Ohio State University, Colubmus, OH, USA

Submitted to: The Astrophysical Journal
*Preprints available on the web at* `http://arxiv.org/abs/1403.4241`

---

# OTHER PAPERS OF INTEREST

## Comparative Orbital Evolution of Transient Uranian Co-orbitals: Exploring the Role of Ephemeral Multi-body Mean Motion Resonances

**C. de la Fuente Marcos**[1] **and R. de la Fuente Marcos**[1]

[1] Universidad Complutense de Madrid, Ciudad Universitaria, E-28040, Madrid, Spain

Uranus has three known co-orbitals: 83982 Crantor (2002 $GO_9$), 2010 $EU_{65}$ and 2011 $QF_{99}$. All of them were captured in their current resonant state relatively recently. Here, we perform a comparative analysis of the orbital evolution of these transient co-orbitals to understand better how they got captured in the first place and what makes them dynamically unstable. We also look for additional temporary Uranian co-orbital candidates among known objects. Our $N$-body simulations show that the long-term stability of 2011 $QF_{99}$ is controlled by Jupiter and Neptune; it briefly enters the 1:7 mean motion resonance with Jupiter and the 2:1 with Neptune before becoming a Trojan

and prior to leaving its tadpole orbit. During these ephemeral two-body mean motion resonance episodes, apsidal corotation resonances are also observed. For known co-orbitals, Saturn is the current source of the main destabilizing force but this is not enough to eject a minor body from the 1:1 commensurability with Uranus. These objects must enter mean motion resonances with Jupiter and Neptune in order to be captured or become passing Centaurs. Asteroid 2010 $EU_{65}$, a probable visitor from the Oort cloud, may have been stable for several Myr due to its comparatively low eccentricity. Additionally, we propose 2002 $VG_{131}$ as the first transient quasi-satellite candidate of Uranus. Asteroid 1999 $HD_{12}$ may signal the edge of Uranus' co-orbital region. Transient Uranian co-orbitals are often submitted to complex multi-body ephemeral mean motion resonances that trigger the switching between resonant co-orbital states, making them dynamically unstable. In addition, we show that the orbital properties and discovery circumstances of known objects can be used to outline a practical strategy by which additional Uranus' co-orbitals may be found.

**To appear in: Monthly Notices of the Royal Astronomical Society**
*For preprints, contact* `nbplanet@fis.ucm.es`
*or on the web at* `http://arxiv.org/abs/1404.2898`

---

# CONFERENCE CONTRIBUTIONS

## Small Bodies Dynamics 2014

**2014 August 24-28, Ubatuba, Brazil**
`http://sbd14.sciencesconf.org`

The Small Bodies Dynamics (SBD) meeting intends to provide a new space for in-depth and stimulating discussions and talks on all aspects of minor bodies dynamics. Topics covered by this meeting will involve the dynamical evolution of asteroids, TNOs, satellites, rings, dust, and space probes. The SBD meeting will feature invited talks on a range of topics, contributed talks, and posters.

The meeting will take place in the Hotel Wembly Inn, in Ubatuba, SP, Brazil, on August 24-28th. More information on the conference is available at: `http://sbd14.sciencesconf.org`

---

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 accepted papers
⋆ Titles of submitted (but not yet accepted) papers and conference articles
⋆ 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`