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DISTANT EKOs

The Kuiper Belt Electronic Newsletter

Edited by: Joel Wm. Parker

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CONTENTS

NEWS & ANNOUNCEMENTS

Since the previous issue of the Distant EKOs newsletter there was an announcement by Showalter et al. of the discovery of yet another satellite of Pluto using the *Hubble Space Telescope*. The satellite has a magnitude of $V = 27.0 \pm 0.3$ and is designated S/2012 (134340) 1, but its current nickname is simply "P5" since this now makes five satellites around the (former) planet. It has an orbital period of 20.2 ± 0.1 days at a distance of about 42000 ± 2000 km, putting P5 close to the 1:3 mean motion resonance with Charon.
IAU Circular 9253: `http://www.cbat.eps.harvard.edu/iauc/09200/09253.html`

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There were 2 new TNO discoveries announced since the previous issue of *Distant EKOs*:

2011 JF31, 2012 HG84

and 2 new Centaur/SDO discoveries:

2011 UQ62, 2012 PD26

Reclassified objects:

2011 GY61 (TNO $\rightarrow$ SDO)

Objects recently assigned numbers:

2009 HH36 = (332685)

Current number of TNOs: 1251 (including Pluto)
Current number of Centaurs/SDOs: 356
Current number of Neptune Trojans: 8

Out of a total of 1615 objects:

641 have measurements from only one opposition

622 of those have had no measurements for more than a year

319 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

KCTF Evolution of Trans-Neptunian Binaries: Connecting Formation to Observation

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Recent observational surveys of trans-neptunian binary (TNB) systems have dramatically increased the number of known mutual orbits. Our Kozai Cycle Tidal Friction (KCTF) simulations of synthetic trans-neptunian binaries show that tidal dissipation in these systems can completely reshape their original orbits. Specifically, solar torques should have dramatically accelerated the semimajor axis decay and circularization timescales of primordial (or recently excited) TNBs. As a result, our initially random distribution of TNBs in our simulations evolved to have a large population of tight circular orbits. This tight circular population appears for a range of TNO physical properties, though a strong gravitational quadrupole can prevent some from fully circularizing. We introduce a stability parameter to predict the effectiveness of KCTF on a TNB orbit, and show that a number of known TNBs must have a large gravitational quadrupole to be stable.

Published in: Icarus, 220, 947 (2012 August)

Preprints available on the web at `http://arxiv.org/abs/1206.5841`

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The Orbit of Charon is Circular

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We present a detailed analysis of the orbit of Charon where we show its orbit to be circular. This analysis explores the effects of surface albedo variations on the astrometry and the resulting errors in the orbital elements. We present two new epochs of data from the Hubble Space Telescope taken in 2008 and 2010 and combine that with a re-analysis of previously published data from 1992 and 2002. Our adopted two-body Keplerian orbital elements for Charon are $P = 6.3872273 \pm 0.0000003$ days, $a = 19573 \pm 2$ km, $e = 0.$, $i = 96.218 \pm 0.008$ deg, $L = 4.50177 \pm 0.00018$ rad, and $\Omega = 3.89249 \pm 0.00012$ rad for an epoch of JDT=2452600.5 in the J2000 reference frame. The 1-σ upper limit to the eccentricity is 7.5×10^{-5}. The predicted uncertainty in the position of Charon relative to Pluto at the time of the New Horizons encounter based on this orbit is 8 km.

Published in: The Astronomical Journal, 144, 15 (2012 July)

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Mutual Events in the Cold Classical Transneptunian Binary System Sila and Nunam

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Hubble Space Telescope observations between 2001 and 2010 resolved the binary components of the Cold Classical transneptunian object (79360) Sila-Nunam (provisionally designated 1997 CS_{29}). From these observations we have determined the circular, retrograde mutual orbit of Nunam relative to Sila with a period of 12.50995±0.00036 days and a semimajor axis of 2777±19 km. A multi-year season of mutual events, in which the two near-equal brightness bodies alternate in passing in front of one another as seen from Earth, is in progress right now, and on 2011 February 1 UT, one such event was observed from two different telescopes. The mutual event season offers a rich opportunity to learn much more about this barely-resolvable binary system, potentially including component sizes, colors, shapes, and albedo patterns. The low eccentricity of the orbit and a photometric lightcurve that appears to coincide with the orbital period are consistent with a system that is tidally locked and synchronized, like the Pluto-Charon system. The orbital period and semimajor axis imply a system mass of (10.84±0.22) × 10^{18} kg, which can be combined with a size estimate based on Spitzer and Herschel thermal infrared observations to infer an average bulk density of $0.72^{+0.37}_{-0.23}$ g cm^{-3}, comparable to the very low bulk densities estimated for small transneptunian binaries of other dynamical classes.

Published in: Icarus, 220, 74 (2012 July)

Preprints and ephemerides available at

`http://www2.lowell.edu/users/grundy/abstracts/2012.Sila-Nunam.html`

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Short-term Variability of 10 Trans-Neptunian Objects

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We present our latest results about short-term variability of Trans-Neptunians Objects (TNOs). We performed broadband CCD photometric observations using several telescopes in Spain, and in Chile. We present results based on 3 years of observations, and we report the short-term variability of 10 TNOs. Our sample of studied targets contains Classical objects: (275809) 2001 QY_{297}, (307251) 2002 KW_{14}, (55636) 2002 TX_{300},

2004 NT_{33}, (230965) 2004 XA_{192}, and (202421) 2005 UQ_{513}, a Resonant body: (84522) 2002 TC_{302}, a Scattered target: (44594) 1999 OX_3, and two Detached objects: (145480) 2005 TB_{190}, and (40314) 1999 KR_{16}. For each target, lightcurves as well as possible rotation periods and photometric amplitudes are reported. The majority of the observed objects present a low peak-to-peak amplitude, <0.15 mag. Just two objects exhibit lightcurve amplitudes higher than 0.15 mag: (275809) 2001 QY_{297}, and (307251) 2002 KW_{14}. We remark two biases in the literature, previously studied in Thirouin et al. (2010) and confirmed by this new study: a bias toward objects with small amplitude lightcurve and a second one against objects with long rotational period in the database of published rotational periods. We derived constraints on physical properties of some targets. We also report solar phase curves of (40314) 1999 KR_{16}, and (44594) 1999 OX_3 for solar phase angles from 0° to around 2°. Part of our discussion is focused on the study of (275809) 2001 QY_{297} which turned out to be an asynchronous binary system.

Published in: Monthly Notices of the Royal Astronomical Society, 424, 3156 (2012 August)
For preprints, contact thirouin@iaa.es
or on the web at http://arxiv.org/abs/1207.2044 and
http://onlinelibrary.wiley.com/doi/10.1111/j.1365-2966.2012.21477.x/full

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Collisional Evolution of Trans-Neptunian Object Populations in a Nice Model Environment

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Almost twenty years of observations of the trans-neptunian region have shed light on the overall dynamical structure of the TNO (trans-neptunian objects) populations and absolute magnitude distributions. The TNO region can be inserted in the global frame of the dynamical evolution of the giant planets, as described by the Nice model. Any reliable collisional evolution model should account for dynamical effects and should produce results that meet the constraints imposed by current observables. With this aim, we have developed a code package (Asteroid-LIke Collisional ANd Dynamical Evolution Package: ALICANDEP), that is a collisional evolution code that includes statistical elimination of objects by dynamical effects within the frame of a disc migrating and gradually dynamically exciting, as well as the dynamical migration of objects between regions. Moreover, we included the possibility to distinguish between dynamically cold and hot bodies in the main classical belt and to keep track of primordial bodies in the whole region. Finally, we performed a large number of numerical simulations varying physical parameters, boundary and initial conditions, in order to match the current observables and the dynamical conditions of the Nice model. Our results are in agreement with those observables and can explain the flattened size distributions in the 30–100 km size range. This allows to constrain the original mass of the belt (not less than 50 Earth masses), that is compatible with initial shallow size distributions below 100 km. ALICANDEP also finds an extremely high probability for the existence of at least one more large (>1700 km) object yet to be discovered in the Outer Belt. This model supports the reliability of the Nice model and it can be a suitable tool to statistically study many features.

Published in: Monthly Notices of the Royal Astronomical Society, 423, 1254
For preprints, contact acb@ua.es

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Characterisation of Candidate Members of (136108) Haumea's Family: II. Follow-up Observations

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Context. From a dynamical analysis of the orbital elements of transneptunian objects (TNOs), Ragozzine & Brown reported a list of candidate members of the first collisional family found among this population, associated with (136 108) Haumea (a.k.a. 2003 EL_{61}).

Aims. We aim to distinguish the true members of the Haumea collisional family from interlopers. We search for water ice on their surfaces, which is a common characteristic of the known family members. The properties of the confirmed family are used to constrain the formation mechanism of Haumea, its satellites, and its family.

Methods. Optical and near-infrared photometry is used to identify water ice. We use in particular the CH_4 filter of the Hawk-I instrument at the European Southern Observatory Very Large Telescope as a short H-band (H_S), the $(J - H_S)$ colour being a sensitive measure of the water ice absorption band at 1.6 μm.

Results. Continuing our previous study headed by Snodgrass, we report colours for 8 candidate family members, including near-infrared colours for 5. We confirm one object as a genuine member of the collisional family (2003 UZ_{117}), and reject 5 others. The lack of infrared data for the two remaining objects prevent any conclusion from being drawn. The total number of rejected members is therefore 17. The 11 confirmed members represent only a third of the 36 candidates.

Conclusions. The origin of Haumea's family is likely to be related to an impact event. However, a scenario explaining all the peculiarities of Haumea itself and its family remains elusive.

Published in: Astronomy and Astrophysics, 544, A137 (2012 August)

For preprints, contact `benoit.carry@esa.int`

or on the web at `http://arxiv.org/abs/1207.6491`

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2004 KV18 – A Visitor from the Scattered Disk to the Neptune Trojan Population

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We have performed a detailed dynamical study of the recently identified Neptunian Trojan 2004 KV18, only the second object to be discovered librating around Neptune's trailing Lagrange point, L5. We find that 2004 KV18 is moving on a highly unstable orbit, and was most likely captured from the Centaur population at some point in the last ∼1 Myr, having originated in the Scattered Disk, beyond the orbit of Neptune. The instability of 2004 KV18 is so great that many of the test particles studied leave the Neptunian Trojan cloud within just ∼0.1 – 0.3 Myr, and it takes just 37 million years for half of the 91125 test particles created to study its dynamical behaviour to be removed from the Solar system entirely. Unlike the other Neptunian Trojans previously found to display dynamical instability on hundred million year timescales (2001 QR322 and 2008 LC18), 2004 KV18 displays such extreme instability that it must be a temporarily captured Trojan, rather than a primordial member of the Neptunian Trojan population. As such, it offers a fascinating insight

into the processes through which small bodies are transferred around the outer Solar system, and represents an exciting addition to the menagerie of the Solar system's small bodies.

To appear in: Monthly Notices of the Royal Astronomical Society
Preprints available on the web at `http://arxiv.org/abs/1207.2925`

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Survey of Kozai Dynamics Beyond Neptune

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We study the Kozai dynamics affecting the orbital evolution of trans-neptunian objects being captured or not in MMR with Neptune. We provide energy level maps of the type (ω, q) describing the possible orbital paths from Neptune up to semimajor axis of hundreds of AU. The dynamics for non resonant TNOs with perihelion distances, q, outside Neptune's orbit, a_N, is quite different from the dynamics of TNOs with $q < a_N$, already studied in previous works. While for the last case there are stable equilibrium points at $\omega = 0°, 90°, 180°$ and $270°$ in a wide range of orbital inclinations, for the former case it appears a family of stable equilibrium points only at a specific value of the orbital inclination, $i \sim 62°$, that we call critical inclination. We show this family of equilibrium points is generated by a mechanism analogue to which drives the dynamics of an artificial satellite perturbed by an oblate planet. The planetary system also generates an oscillation in the longitude of the perihelion of the TNOs with $i \sim 46°$, being Eris a paradigmatic case. We discuss how the resonant condition with Neptune modify the energy level curves and the location of equilibrium points. The asymmetric librations of resonances of the type 1:N generate a distortion in the energy level curves and in the resulting location of the equilibrium points in the phase space (ω, q). We study the effect on the Kozai dynamics due to the diffusion process in a that occurs in the Scattered Disk. We show that a minimum orbital inclination is required to allow substantial variations in perihelion distances once the object is captured in MMR and that minimum inclination is greater for greater semimajor axis.

Published in: Icarus 220, 392 (2012 August)
For preprints, contact `gallardo@fisica.edu.uy`
or on the web at `http://arxiv.org/abs/1205.4935`

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Space Weathering and the Color Indexes of Minor Bodies in the Outer Solar System

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The surfaces of small bodies in the outer Solar System are rich in organic compounds and carbonaceous refractories mixed with ices and silicates. As made clear by dedicated laboratory experiments space weathering (e.g. energetic ion bombardment) can produce red colored materials starting from bright and spectrally flat ices. In a classical scenario, the space weathering processes "nurture" alter the small bodies surface spectra but are in competition with resurfacing agents that restore the original colors, and the result of these competing processes continuously modifying the surfaces is supposed to be responsible for the observed spectral variety of those small bodies. However an alternative point of view is that the different colors are due to "nature" i.e. to the different primordial composition of different objects. In this paper we present a model, based on laboratory results, that gives an original contribution to the "nature" versus "nurture" debate by addressing the case of surfaces showing different fractions of rejuvenated vs space weathered surface, and calculating the corresponding color variations. We will show how a combination of increasing dose coupled to different resurfacing can reproduce the whole range of observations of small outer Solar System bodies. Here we demonstrate, for the first time that objects having a fully weathered material turn back in the color-color diagrams. At the same time, object with the different ratio of pristine and weathered surface areas lay on specific lines in color-color diagrams, if exposed to the same amount of irradiation.

Published in: Icarus 221, 12 (2012 September)

For preprints, contact zuzana@inaf.oact.it

OTHER PAPERS OF INTEREST

The Influence of Mean Motion Resonances on the Outer Kuiper Belt: Does the Outer Kuiper Belt have a Future?

Fred A. Franklin[1] and Paul R. Soper

[1] Harvard-Smithsonian Center for Astrophysics, USA

Preprint available on the web at http://arxiv.org/abs/1207.4762

JOB ANNOUNCEMENTS

Two Postdoctoral Fellowships: The OSSOS Survey

University of British Columbia (Vancouver)
National Research Council of Canada (Victoria)
Universite de Franche-Compte (Besancon, France)

The Outer Solar Systems Origins Survey (OSSOS) is an approved Large Program for four years on the Canada-France-Hawaii Telescope (see `http://www.cfht.hawaii.edu/en/science/LP_13_16/`), to detect a large sample of outer Solar System moving objects. Two postdoctoral fellows are sought to begin in 2013 to be involved in discovery/tracking observations, detected object exploitation, and scientific analysis/modelling of the survey's results. Previous work in the field of outer Solar System small-body science is needed. Depending on the postdoctoral fellow's interests and the eligibility for various funding sources, the work might be undertaken at either the University of British Columbia (Vancouver), the National Research Council of Canada (Victoria), or the Universite de Franche-Compte (Besancon, France). Enquiries should be made via email, with a statement of interests and CV enclosed, to B. Gladman (`gladman@astro.ubc.ca`) by September 14, 2012.

CONFERENCE INFORMATION

The Pluto System on the Eve of Exploration by New Horizons: Perspectives And Predictions

22-26 July 2013
Johns Hopkins Applied Physics Laboratory
Laurel, Maryland USA
`https://dnnpro.outer.jhuapl.edu/plutoscience/Home.aspx`

In mid-2015, NASA's New Horizons mission will conduct the first spacecraft reconnaissance of the Pluto system. In preparation for that flyby, the New Horizons project team will hold a scientific conference at The Johns Hopkins Applied Physics Laboratory 22-26 July 2013. The conference objectives are:

- To integrate information about this planet, its satellites, and their context in the Kuiper Belt.
- To encourage groundbased and spacebased proposals to provide additional context alongside the New Horizons encounter. And,
- To inform about the 6-month long New Horizons encounter for those interested in proposing to the Pluto System Data Analysis Program.

The meeting's program, invited talks, logistical information, and opportunities for contributed talks and posters and more information can be found at at:
`https://dnnpro.outer.jhuapl.edu/plutoscience/Home.aspx`
sign up to the meeting listserv at:
`http://pluto.jhuapl.edu/conference/eform/conf_info_form.php`

IAU Symposium 299:
Exploring the Formation and Evolution of Planetary Systems

2-7 June 2013
Victoria, BC, Canada
http://www.iaus299.org
https://www.facebook.com/events/376085279113847/
Email: iaus-299@di.utoronto.ca

This is the first announcement for the 299th Symposium of the International Astronomical Union (IAU), "Exploring the Formation and Evolution of Planetary Systems", co-organized by the Dunlap Institute for Astronomy & Astrophysics and the National Research Council of Canada. The goal of this meeting is to bring together the communities studying the formation of planets in protoplanetary discs and those who study evolved exoplanet systems. The timing is chosen to highlight the first results from a number of new facilities and instruments which will impact these fields. Topics will include:

- Observations of protoplanetary discs, debris discs and exoplanets
- Planetesimal and planet formation
- Exoplanet atmospheres and interior structure
- Dynamics in planetary systems: migration, multiplicity and planet-disc interactions

The meeting will be held at the Victoria Conference Centre in the heart of picturesque Victoria, British Columbia, on Canada's Pacific coast. Local attractions include whale watching, wine tours, the world-famous Butchart Gardens, and the Dominion Astrophysical Observatory. Excellent beaches, diving, camping and hiking are all within a day's drive from Victoria.

Pre-Registration

Registration will open on 1 September 2012, but those interested in attending the meeting are welcome to submit their names to our pre-registration list. Pre-registrants will be sent the invitation to register for the meeting directly, but places are not reserved once registration is officially opened. There will be a hard limit of 200 attendees for the symposium. To pre-register and be placed on the mailing list, just send an email indicating your interest to the conference email: iaus-299@di.utoronto.ca.

Financial Assistance

In keeping with the spirit of the IAU Symposia, the costs of the meeting will be kept as low as possible. In addition, financial assistance in the form of IAU Support Grants is available for those needing financial assistance to attend. All student attendees who register in the Early Registration period (1 Sept - 7 Dec 2012) will receive financial support. The deadline for submission of grant applications to the Science Organizing Committee is 7 December 2012; forms and directions are available on the symposium website, http://www.iaus299.org .

Key Dates

1 Sept 2012:	Early Registration Opens
7 Dec 2012:	Deadline for Early Registration and Applications for IAU Support Grants
31 March 2013:	Deadline for Registration and Abstract Submission

For more information, please visit our website, facebook event entry or email the conference. We hope to see you in Victoria in June 2013!

Brenda Matthews

LOC Chair, on behalf of the LOC and SOC

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`