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DISTANT EKOs

The Kuiper Belt Electronic Newsletter

Edited by: Joel Wm. Parker

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CONTENTS

NEWS & ANNOUNCEMENTS

There were no new TNO discoveries announced since the previous issue of *Distant EKOs* and 1 new Centaur/SDO discovery:

2009 HH36

Current number of TNOs: 1093 (including Pluto)
Current number of Centaurs/SDOs: 243
Current number of Neptune Trojans: 6

Out of a total of 1342 objects:
553 have measurements from only one opposition
539 of those have had no measurements for more than a year
288 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

On the Origin of the Kuiper Belt

Rodney da Silva Gomes[1]

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I review the work that has been done so far aiming at the understanding of the origin of the Kuiper belt. Three peculiar characteristics of the Kuiper belt are used as constraints for the formation models. These are the unexpected dynamical excitation of the orbits, the Kuiper belt outer edge near the 1:2 resonance with Neptune and the mass paucity of the belt. Among the various scenarios proposed, those based on a primordial planetary migration give the best results. In particular, the Nice model is analyzed with respect to its coherence with the present characteristics of the belt. Special attention is given to the controversy on the origin of the Kuiper belt cold population.

To appear in: Celestial Mechanics and Dynamical Astronomy
For preprints, contact `rodney@on.br`

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Minimum Mass Solar Nebulae and Planetary Migration

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The Minimum Mass Solar Nebula (MMSN) is a protoplanetary disk that contains the minimum amount of solids necessary to build the planets of the Solar System. Assuming that the giant planets formed in the compact configuration they have at the beginning of the "Nice model", Desch (2007) built a new MMSN. He finds a decretion disk, about ten times denser than the well-known Hayashi MMSN. The disk profile is almost stationary for about ten million years. However, a planet in a protoplanetary disk migrates. In a massive, long-lived disk, this question has to be addressed. With numerical simulations, we show that the four giant planets of the Solar System could not survive in this disk. In particular, Jupiter enters the type III, runaway regime, and falls into the Sun like a stone. Known planet-planet interaction mechanisms to prevent migration, fail in this nebula, in contrast to the Hayashi MMSN. Planetary migration constrains the construction of a MMSN. We show how this should be done self-consistently.

To appear in: The Astrophysical Journal
For preprints, contact `crida@tat.physik.uni-tuebingen.de`
or on the web at `http://arxiv.org/abs/0903.5077`

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The Canada-France Ecliptic Plane Survey - L3 Data Release: The Orbital Structure of the Kuiper Belt

JJ Kavelaars[1], R.L. Jones[1,2], B.J. Gladman[2], J-M. Petit[2,3], J.Wm. Parker[4], C. Van Laerhoven[2], P. Nicholson[5], P. Rousselot[3], H. Scholl[6], O. Mousis[3], B. Marsden[7], P. Benavidez[8], A. Bieryla[4], A. Campo Bagatin[8], A. Doressoundiram[9], J.L. Margot[5], I. Murray[1], and C. Veillet[10]

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We report the orbital distribution of the trans-neptunian comets discovered during the first discovery year of the Canada-France Ecliptic Plane Survey (CFEPS). CFEPS is a Kuiper belt object survey based on observations acquired by the Very Wide component of the Canada-France-Hawaii Telescope Legacy Survey (LS-VW). The first year's detections consist of 73 Kuiper belt objects, 55 of which have now been tracked for three years or more, providing precise orbits. Although this sample size is small compared to the world-wide inventory, because we have an absolutely calibrated and extremely well-characterized survey (with known pointing history) we are able to de-bias our observed population and make unbiased statements about the intrinsic orbital distribution of the Kuiper Belt. By applying the (publically-available) CFEPS Survey Simulator to models of the true orbital distribution and comparing the resulting simulated detections to the actual detections made by the survey, we are able to rule out several hypothesized Kuiper belt object orbit distributions. We find that the the main classical belt's so-called 'cold' component is confined in semi-major axis (a) *and eccentricity* (e) compared to the more extended 'hot' component; the cold-component is confined to lower e and does not stretch all the way out to the 2:1 resonance but rather depletes quickly beyond a=45 AU. For the cold main classical belt population we find a robust population estimate of $N(\mathrm{H}_g < 10) = 60 \pm 10 \times 10^3$ and find that the hot-component of the main classical belt represents $\sim 60\%$ of the total population. The inner classical belt (sunward of the 3:2 mean-motion resonance) has a population of roughly 2000 TNOs with absolute magnitudes $\mathrm{H}_g < 10$, and may not share the inclination distribution of the main classical belt. We also find that the plutino population lacks a cold low-inclination component, and so, the population is somewhat larger than recent estimates; our analysis shows a plutino population of $\mathrm{N}(\mathrm{H}_g < 10) \sim 25^{+25}_{-12} \times 10^3$ compared to our estimate of the size of main classical Kuiper belt population of $\mathrm{N}(\mathrm{H}_g < 10) \sim 126^{+50}_{-46} \times 10^3$.

Published in: The Astronomical Journal, 137, 4917 (2009 June)

Reprints available online at

`http://www.cfeps.net/CFEPS/Survey_Simulator_files/aj_137_6_4917.pdf`

The CFEPS survey simulator and additional information are available at

`http://www.cfeps.net/CFEPS/Survey_Simulator.html`

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Simulations for the Original Distribution of KBOs

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Using the N-body dynamical model that includes the sun, the 8 planets, Pluto, UB313 and massless particles, we simulate the orbital evolution of 551 Kuiper Belt Objects (KBOs) with known parameters. The initial conditions of the simulations are the currently observed orbital parameters. The integration backtracks from now to -10×10^8 yr. The results show that about 10×10^8 years ago, more than 1/3 of the presently observed KBOs resided in the region of the present Kuiper main belt, a few were located inside the Neptune orbit, and the rest were beyond 50 AU; and that about 4.5×10^8 years ago, all the objects in the Kuiper main belt exhibited a rather good normal distribution, without so many objects concentrated in the Neptune's 3:2 resonance region, as at present time.

Published in: Chinese Astronomy and Astrophysics, 33, 188 (2009 June)

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A Subaru Pencil-beam Search for $m_R \sim 27$ Trans-neptunian Bodies

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We present the results of an archival search for Trans-neptunian objects (TNOs) in an ecliptic field observed with Subaru in 2002. The depth of the search allowed us to find 20 new TNOs with magnitudes between $R = 24$ and 27. We fit a double power law model to the data; the most likely values for the bright and faint power-law exponents are: α_1=$0.73^{+0.08}_{-0.09}$, and α_2=$0.20^{+0.12}_{-0.14}$; the differential number density at $R = 23$ is σ_{23}=$1.46^{+0.14}_{-0.12}$ and and the break magnitude is R_{eq}=$25.0^{+0.8}_{-0.6}$. This is the most precise measurement of the break in the TNO luminosity function to date. The break in the size distribution corresponds to a diameter of $D = 90 \pm 30$ km assuming a 4% albedo.

Published in: The Astrophysical Journal, 696, 91 (2009 May 1)
For preprints, contact cfuentes@cfa.harvard.edu
or on the web at http://arxiv.org/abs/0809.4166

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ESO-Large Program on TNOs: Near-infrared Spectroscopy with SINFONI

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We present in this work the observations performed with SINFONI in the framework of a new ESO-Large Program (2006–2008) on Trans-Neptunian Objects (TNOs) and Centaurs. We obtained 21 near-infrared (1.49 to 2.4 microns) spectra of high quality, including 4 spectra of objects never observed before. We search for the presence of features due to ices, particularly water ice. Eris is the only object showing deep methane ice absorption bands. The spectra of 4 objects are featureless, and 6 others show clearly the presence of water ice. For 7 objects, the detections are more ambiguous, but absorption bands could be embedded in the noise. The 3 remaining spectra are too noisy to draw any reliable conclusion. The possible amount of water ice on each object's surface has been computed. The analysis shows that some objects present strong compositional heterogeneities over the surface (e.g. Chariklo), while some others are completely homogeneous (e.g. Quaoar).

Published in: Icarus, 201, 272 (2009 May)

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Chaotic Capture of Neptune Trojans

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Neptune Trojans (NTs) are swarms of outer solar system objects that lead/trail planet Neptune during its revolutions around the Sun. Observations indicate that NTs form a thick cloud of objects with a population perhaps $\sim$10 times more numerous than that of Jupiter Trojans and orbital inclinations reaching $\sim 25°$. The high inclinations of NTs are indicative of capture instead of in situ formation. Here we study a model in which NTs were captured by Neptune during planetary migration when secondary resonances associated with the mean-motion commensurabilities between Uranus and Neptune swept over Neptune's Lagrangian points. This process, known as chaotic capture, is similar to that previously proposed to explain the origin of Jupiter's Trojans. We show that chaotic capture of planetesimals from an $\approx$35 Earth-mass planetesimal disk can produce a population of NTs that is at least comparable in number to that inferred from current observations. The large orbital inclinations of NTs are a natural outcome of chaotic capture. To obtain the $\sim$4:1 ratio between high- and low-inclination populations suggested by observations, planetary migration into a dynamically excited planetesimal disk may be required. The required stirring could have been induced by Pluto-sized and larger objects that have formed in the disk.

Published in: The Astronomical Journal, 137, 5003 (2009 June)

PAPERS RECENTLY SUBMITTED TO JOURNALS

A Search for Occultations of Bright Stars by Small Kuiper Belt Objects using Megacam on the MMT

F.B. Bianco[1,2,3], P. Protopapas[2,3], B.A. McLeod[2], C.R. Alcock[2], M.J. Holman[2], and M.J. Lehner[4,1,2]

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[4] Institute of Astronomy and Astrophysics, Academia Sinica. P.O. Box 23-141, Taipei 106, Taiwan

Submitted to: The Astronomical Journal

Preprints available on the web at http://arxiv.org/abs/0903.3036

CONFERENCE CONTRIBUTIONS

Dynamic Resonance Effects in the Statistical Distributions of Asteroids and Comets

B.R. Mushailov[1] and V.S. Teplitskaya[1]

[1] Sternberg State Astronomical Institute, Lomonosov Moscow State University, Russia

To appear in:
"100 years since Tunguska phenomenon: Past, present and future" (June 26-28, 2008. Russia, Moscow), and "International Conference "Modern problems of astronomy" (August 12-18, 2007, Ukraine, Odessa)

Preprint available on the web at http://arxiv.org/abs/0904.0371

OTHER PAPERS OF INTEREST

Odyssey: A Solar System Mission

B. Christophe, et al.

Published in: Experimental Astronomy, 23, 529 (2009 March)

Preprints available on the web at http://arxiv.org/abs/0711.2007

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Quantum Physics Exploring Gravity in the Outer Solar System: The Sagas Project

P. Wolf, et al.

Published in: Experimental Astronomy, 23, 651 (2009 March)

Preprints available on the web at http://arxiv.org/abs/0711.0304

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How Well Do We Know the Orbits of the Outer Planets?

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Published in: The Astrophysical Journal, 697, 1226 (2009 June)

For preprints, contact gpage@gmu.edu
or on the web at http://arxiv.org/abs/0905.0030

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Numerical Simulations of Impacts Involving Porous Bodies. II. Comparison with Laboratory Experiments

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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:

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