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DISTANT EKOs

The Kuiper Belt Electronic Newsletter

Edited by: Joel Wm. Parker

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CONTENTS

NEWS & ANNOUNCEMENTS

ACS Astrochemistry Subdivision Opens Up Affiliate Status for AAS and DPS Members
`http://www.chem.hawaii.edu/Bil301/ACSAstrochemistry.html`

The recently established Astrochemistry Subdivision of the Division of Physical Chemistry of the American Chemical Society (ACS) invites members of the American Astronomical Society and of the Division of Planetary Sciences to join the ACS Astrochemistry Subdivision as an Affiliate Member. Please complete a division application form:

`http://portal.acs.org/portal/PublicWebSite/membership/td/join/CTP_004160`

and email (`service@acs.org`) or fax (614-447-3671) it to ACS Member Services. Note that the PHYS annual membership dues are $15, which should be remitted with the form. Please indicate that you would like to join the Astrochemistry Subdivision.

The Subdivision of Astrochemistry provides an interdisciplinary "home" for individuals interested in astrochemically related research via experiments, theory, observations, space missions, and modeling. Astrochemistry is the study of the abundances and chemical reactions of atoms, molecules, and ions and how they interact with radiation in the gas phase and in the condensed phase in Solar Systems and in the Interstellar Medium (ISM) leading to the formation and breaking of chemical bonds. Astrochemistry presents both an interdisciplinary and a multidisciplinary field with ties to the traditional disciplines chemistry, planetary science, chemical biology, physics, and astronomy. Here, chemistry, defined as the change of matter is vital in unraveling the chemical and astrobiological evolution of matter on the microscopic (elementary chemical reactions) and also on the macroscopic level (planets, moons, interstellar medium). Since the present composition of each macroscopic environment reflects the matter from which it was formed and the chemical processes which have changed the chemical nature since the origin, a detailed investigation of the processes altering the chemical composition of the pristine environment is critical to rationalize its contemporary makeup and to understand its origin and chemistry. Astrochemistry exploits molecular tracers to rationalize the origin and chemical evolution of the Interstellar Medium and of Solar Systems by combining laboratory studies (chemical dynamics and kinetics, spectroscopy), theoretical chemistry, astrochemical modeling, astronomical observations, and space missions. This work requires a concerted inter-disciplinary relationship between chemists, physicists, astronomers, chemical biologists, and planetary scientists.

We would also like to thank those of you who supported the establishment of the Astrochemistry Subdivision! We hope that this creates a thriving Astrochemistry Subdivision that is able to serve the community.

Best regards,
Ralf Kaiser (Chair), Arthur Suits (Chair-Elect), Martin Head-Gordon (Vice-Chair)

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There were 4 new Centaur/SDO discoveries announced since the previous issue of *Distant EKOs*:

2010 GB174, 2013 AX158, 2013 JX14, 2013 LU28

Current number of TNOs: 1260 (including Pluto)
Current number of Centaurs/SDOs: 377
Current number of Neptune Trojans: 9

Out of a total of 1646 objects:
- 651 have measurements from only one opposition
  - 634 of those have had no measurements for more than a year
    - 325 of those have arcs shorter than 10 days

PAPERS ACCEPTED TO JOURNALS

Plutino Detection Biases, Including the Kozai Resonance

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Because of their relative proximity within the transneptunian region, the plutinos (objects in the 3:2 mean-motion resonance with Neptune) are numerous in flux-limited catalogs, and well-studied theoretically. We perform detailed modelling of the on-sky detection biases for plutinos, with special attention to those that are simultaneously in the Kozai resonance. In addition to the normal 3:2 resonant argument libration, Kozai plutinos also show periodic oscillations in eccentricity and inclination, coupled to the argument of perihelion (ω) oscillation. Due to the mean-motion resonance, plutinos avoid coming to pericenter near Neptune's current position in the ecliptic plane. Because Kozai plutinos are restricted to certain values of ω, perihelion always occurs out of the ecliptic plane, biasing ecliptic surveys against finding these objects. The observed Kozai plutino fraction $f_{\rm koz}^{\rm obs}$ has been measured by several surveys, finding values between 8% and 25%, while the true Kozai plutino fraction $f_{\rm koz}^{\rm true}$ has been predicted to be between 10% and 30% by different giant planet migration simulations. We show that $f_{\rm koz}^{\rm obs}$ varies widely depending on the ecliptic latitude and longitude of the survey, so debiasing to find the true ratio is complex. Even a survey that covers most or all of the sky will detect an apparent Kozai fraction that is different from $f_{\rm koz}^{\rm true}$. We present a map of the on-sky plutino Kozai fraction that would be detected by all-sky flux-limited surveys. This will be especially important for the Panoramic Survey Telescope & Rapid Response System (Pan-STARRS) and Large Synoptic Survey Telescope (LSST) projects, which may detect large numbers of plutinos as they sweep the sky. $f_{\rm koz}^{\rm true}$ and the distribution of the orbital elements of Kozai plutinos may be a diagnostic of giant planet migration; future migration simulations should provide details on their resonant Kozai populations.

Published in: The Astronomical Journal, 146, 6 (2013 July)

Preprints available on the web at `http://arxiv.org/abs/1305.1662`

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Initial Planetesimal Sizes and the Size Distribution of Small Kuiper Belt Objects

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The Kuiper Belt is a remnant from the early solar system and its size distribution contains many important constraints that can be used to test models of planet formation and collisional evolution. We show, by comparing observations with theoretical models, that the observed Kuiper Belt size distribution is well matched by coagulation models, which start from an initial planetesimal population with radii of about 1 km, and subsequent collisional evolution. We find that the observed size distribution above $R \sim 30$ km is primordial, i.e., it has not been modified by collisional evolution over the age of the solar system, and that the size distribution below $R \sim 30$ km has been modified by collisions and that its slope is well matched by collisional evolution models that use published strength laws. We investigate in detail the resulting size distribution of bodies ranging from 0.01 km to 30 km and find that its slope changes several times as a function of radius before approaching the expected value for an equilibrium collisional cascade of material strength dominated bodies for $R \lesssim 0.1$ km. Compared to a single power law size distribution that would span the whole range from 0.01 km to 30 km, we find in general a strong deficit of bodies around $R \sim 10$ km and a strong excess of bodies around 2 km in radius. This deficit and excess of bodies are caused by the planetesimal size distribution left over from the runaway growth phase, which left most of the initial mass in small planetesimals, while only a small fraction of the total mass is converted into large protoplanets. This excess mass in small planetesimals leaves a permanent signature in the size distribution of small bodies that is not erased after 4.5 Gyrs of collisional evolution. Observations of the small KBO size distribution can therefore test if large KBOs grew as a result of runaway growth and constrain the initial planetesimal sizes. We find that results from recent KBO occultation surveys and the observed KBO size distribution can be best matched by an initial planetesimal population that contained about equal mass per logarithmic mass bin in bodies ranging from 0.4 km to 4 km in radius. We further find that we cannot match the observed KBO size distribution if most of the planetesimal mass was contained in bodies that were 10 km in radius or larger, simply because their resulting size distribution cannot be sufficiently depleted over 4.5 Gyrs to match observations.

To appear in: The Astronomical Journal
For preprints, contact `hilke@mit.edu`

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Centaurs and Scattered Disk Objects in the Thermal Infrared: Analysis of WISE/NEOWISE Observations

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The Wide-field Infrared Survey Explorer (WISE) observed 52 Centaurs and Scattered Disk Objects in the thermal infrared, including the 15 discoveries that were new. We present analyses of these observations to estimate sizes and mean optical albedos. We find mean albedos of 0.08±0.04 for the entire data set. Thermal fits yield average beaming parameters of 0.9±0.2 that are similar for both SDO and Centaur sub-classes. Biased cumulative size distributions yield size-frequency distribution power law indices ∼ -1.7±0.3.

The data also reveal a relation between albedo and color at the 3-σ level. No significant relation between diameter and albedos is found.

To appear in: The Astrophysical Journal
For preprints, contact bauer@scn.jpl.nasa.gov
or on the web at http://arxiv.org/abs/1306.1862

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The Mass, Orbit, and Tidal Evolution of the Quaoar-Weywot System

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Here we present new adaptive optics observations of the Quaoar-Weywot system. With these new observations we determine an improved system orbit. Due to a 0.39 day alias that exists in available observations, four possible orbital solutions are available with periods of $\sim$11.6, $\sim$12.0, $\sim$12.4, and $\sim$12.8 days. From the possible orbital solutions, system masses of 1.3–1.5 $\pm 0.1 \times 10^{21}$ kg are found. These observations provide an updated density for Quaoar of 2.7–5.0 g cm^{-3}. In all cases, Weywot's orbit is eccentric, with possible values $\sim$0.13–0.16. We present a reanalysis of the tidal orbital evolution of the Quoaor-Weywot system. We have found that Weywot has probably evolved to a state of synchronous rotation, and have likely preserved their initial inclinations over the age of the Solar system. We find that for plausible values of the effective tidal dissipation factor tides produce a very slow evolution of Weywot's eccentricity and semi-major axis. Accordingly, it appears that Weywot's eccentricity likely did not tidally evolve to its current value from an initially circular orbit. Rather, it seems that some other mechanism has raised its eccentricity post-formation, or Weywot formed with a non-negligible eccentricity.

Published in: Icarus, 222, 357 (2013 January)
For preprints, contact wesley.fraser@nrc.ca
or on the web at http://arxiv.org/abs/1211.1016

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The Peculiar Photometric Properties of 2010 WG9: A Slowly Rotating Trans-Neptunian Object from the Oort Cloud

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We present long-term $BVRI$ observations of 2010 WG9, an $\sim$100 km diameter trans-Neptunian object (TNO) with an extremely high inclination of 70 deg discovered by the La Silla-QUEST southern sky survey. Most of the observations were obtained with ANDICAM on the SMARTS 1.3 m at Cerro Tololo, Chile from 2010 December to 2012 December. Additional observations were made with EFOSC2 on the

3.5 m NTT telescope of the European Southern Observatory at La Silla, Chile in 2011 February. The observations reveal a sinusoidal light curve with amplitude 0.14 mag and period 5.4955 ± 0.0025 days, which is likely half the true rotation period. Such long rotation periods have previously been observed only for tidally evolved binary TNOs, suggesting that 2010 WG9 may be such a system. We predict a nominal separation of at least 790 km, resolvable with Hubble Space Telescope and ground-based systems. We measure $B - R = 1.318 \pm 0.029$ and $V - R = 0.520 \pm 0.018$, consistent with the colors of modestly red Centaurs and Damocloids. At I-band wavelengths, we observe an unusually large variation of color with rotational phase, with $R - I$ ranging from 0.394 ± 0.025 to 0.571 ± 0.044. We also measure an absolute R-band absolute magnitude of 7.93 ± 0.05 and solar phase coefficient 0.049 ± 0.019 mag/deg.

To appear in: The Astronomical Journal
Preprints available on the web at `http://arxiv.org/abs/1305.5134`

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Hybrid Fluid/Kinetic Modeling of Pluto's Escaping Atmosphere

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Predicting the rate of escape and thermal structure of Pluto's upper atmosphere in preparation for the New Horizons Spacecraft encounter in 2015 is important for planning and interpreting the expected measurements. Having a moderate Jeans parameter Pluto's atmosphere does not fit the classic definition of Jeans escape for light species escaping from the terrestrial planets, nor does it fit the hydrodynamic outflow from comets and certain exoplanets. It has been proposed for some time that Pluto lies in the region of slow hydrodynamic escape. Using a hybrid fluid/molecular-kinetic model, we previously demonstrated the typical implementation of this model fails to correctly describe the appropriate temperature structure for the upper atmosphere for solar minimum conditions. Here we use a time-dependent solver to allow us to extend those simulations to higher heating rates and we examine fluid models in which Jeans-like escape expressions are used for the upper boundary conditions. We compare these to hybrid simulations of the atmosphere under heating conditions roughly representative of solar minimum and mean conditions as these bracket conditions expected during the New Horizon encounter. Although we find escape rates comparable to those previously estimated by the slow hydrodynamic escape model, and roughly consistent with energy limited escape, our model produces a much more extended atmosphere with higher temperatures roughly consistent with recent observations of CO. Such an extended atmosphere will be affected by Charon and will affect Pluto's interaction with the solar wind at the New Horizon encounter. Since we have previously shown that such models can be scaled, these results have implications for modeling exoplanet atmospheres for which the energy limited escape approximation is often used.

To appear in: Icarus
For preprints, contact `jterwin@lpl.arizona.edu`
or on the web at `http://arxiv.org/abs/1211.3994`

PAPERS RECENTLY SUBMITTED TO JOURNALS

Dynamical Formation of Detached Trans-Neptunian Objects Close to the 2:5 and 1:3 Mean Motion Resonances with Neptune

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Submitted to: Astronomy & Astrophysics

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CONFERENCE INFORMATION

European Planetary Science Congress 2013
2013 September 8-13
London, United Kingdom
http://www.epsc2013.eu
SB8 session "KBOs and Centaurs, latest results from space- and ground-based telescopes"
There are currently 9 contributions submitted for this session

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The Universe Explored by Herschel
2013 October 15-18
ESA-ESTEC, Noordwijk, The Netherlands
http://congrexprojects.com/13a12/
One of the 5 science areas covered by this conference is "The Solar System & its evolution"
There are currently 8 contributions submitted on TNOs, Pluto, Centaurs, Phoebe, etc.

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 ... ??

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`ekonews@boulder.swri.edu`