POSTER ABSTRACTS for MONDAY
Saturn Science Conference

1) Mousis, Olivier: *Interpretation of the $^{14}N/^{15}N$ Ratio Measured in Saturn's Ammonia*

O. Mousis, J. I. Lunine, L. N. Fletcher, K. E. Mandt, D. Gautier, and S. Atreya

The recent derivation of a 1-sigma lower limit for the $^{14}N/^{15}N$ ratio in Saturn's ammonia, which is found to be ~500 (Fletcher et al. 2014), prompts us to revise models of Saturn's formation using as constraints the abundances of heavy elements inferred in its atmosphere. This lower limit is found consistent with the $^{14}N/^{15}N$ ratio (~435) measured by the Galileo probe at Jupiter and implies that the two giant planets were essentially formed from the same nitrogen reservoir in the nebula, which is N_2 (Fletcher et al. 2014). However, in contrast with Jupiter whose C and N enrichments are uniform, carbon appears more than twice enriched in Saturn's atmosphere compared to nitrogen. This non-uniform enrichment at Saturn, considered with the recent derivation of a lower limit for the $^{14}N/^{15}N$ ratio, challenges the formation models elaborated so far. Here we propose an alternative formation scenario that may explain all of these properties together.

2) Flasar, F. Michael: *Saturn's Shape from Cassini Radio Occultations*

F. M. Flasar, P. J. Schinder, R. G. French, E. A. Marouf, and A. J. Kliore

We report on the shape of isobaric surfaces in Saturn's atmosphere, derived from thirty-five Cassini radio-occultation soundings that probe from 0.1 mbar to ~1 bar between 70 S and 60 N latitude. To determine this, we use the gravitational coefficients given by Jacobson et al. [1] and the angular velocities at the cloud-top level from the Voyager winds reported by Sanchez-Lavega et al. [2]. To keep the ray-tracing inversion tractable, we assume that the atmosphere is locally axisymmetric and that its angular velocities are functions of the cylindrical radius from the planetary rotation axis; except for near the equator, this is equivalent to assuming that the winds are barotropic. This permits the use of a geopotential incorporating both gravity and differential rotation and ensures that surfaces of constant geopotential, density, and pressure coincide. Note that the "barotropic" assumption need only apply in the atmospheric shell probed by the occultations. The retrieved isobaric surfaces show evidence of moderate baroclinicity. For example, the deviations of the 1-bar and 100-mbar surfaces from the geopotential surface assumed are of order 10-20 km, less than a pressure scale height.

References

[1] Jacobson, R. A., et al., Astron. J., 132, 2520-2526, 2006.
[2] Sanchez-Lavega, A., et al., Icarus, 147, 405-420, 2000.

3) Kurth, W. S.: *Saturn Kilometric Radiation Periodicity after Equinox*

G. Fischer, D.A. Gurnett, W.S. Kurth, S.-Y. Ye, and J.B. Groene

The rotation period of Saturn's magnetosphere was found to vary with time, and changing periodicities were identified in magnetic fields, radio emissions, and charged particles. Here we analyze the varying period of Saturn kilometric radiation (SKR) from 2009 to early 2013, i.e. mainly after Saturn equinox of August 2009. A periodicity analysis is first applied to the complete SKR signal, and second to SKR intensities separated by spacecraft latitude and wave polarization, attributed to SKR from the northern and southern hemisphere, respectively. Our analyses are done with the tracking filter approach of Gurnett et al. (2009a) and by simply following the phases of normalized SKR intensity maxima (north and south) with time. It is shown that SKR periods from the northern and southern hemisphere converged during 2009, crossed shortly after equinox, and coalesced in spring 2010. We will show that SKR from both hemispheres not only exhibited similar periods, but also similar phases from March 2010 until February 2011 and from August 2011 until June 2012. The in-between time interval (March to July 2011) shows a slowdown of the southern SKR rotation rate and a slight increase in rotation speed for the northern SKR before rotation rates and phases become equal again in August 2011. We also identify minor SKR components where the modulation phase deviation exceeds one rotation each time Cassini completes one orbit, i.e. this is consistent with the characteristic of a searchlight-like signal. However, the main SKR signal still acts like a clock with a modulation phase independent of the local time of the observer (Cassini spacecraft). A comparison of SKR periodicities after equinox to the planetary period oscillations of the magnetic field shows major differences, and we compare SKR phases to magnetic field phases to explain the deviations.

4) Hedman, Matthew: *Kronoseismology with Rings, New Clues to Saturn's Interior*

M.M. Hedman and P.D. Nicholson

Twenty years ago, Marley & Porco [1993, Icarus 106, 508] pointed out that Saturn's normal mode oscillations could potentially produce detectable signatures in the rings, but the data available at that time were insufficient to securely identify whether particular ring features were generated by specific planetary oscillations. Using stellar occultation data obtained by the Visual and Infrared Mapping Spectrometer (VIMS) onboard the Cassini spacecraft, we have been able to determine the symmetry properties and pattern speeds of several of these waves. At least six of these features have pattern speeds that are consistent with those predicted for resonances with low-order acoustic oscillations (f-modes) within the planet. These features therefore provide precise estimates of Saturn's normal-mode oscillation frequencies, and should therefore place strong constraints on Saturn's internal structure. We also identified multiple waves with the same number of arms and very similar pattern speeds, indicating that multiple sectoral modes may exist within the planet, something that was not predicted by many planetary interior models. More recently, we have found waves that appear to be generated by persistent gravitational anomalies rotating around the planet at speeds comparable to Saturn's winds. These features could help clarify how deep these winds extend.

5) Crary, Frank: *Joule Heating of the Mid-Latitude Thermosphere: Saturn's other Ring Current*

Saturn's main rings are magnetically connected to Saturn's atmosphere at latitudes between 38 and 48 degrees. The rings do not corotate with the planet and, most likely, neither does the ring ionosphere. This results in a current system which flows across the rings, along field lines and closes in Saturn's mid-latitude ionosphere. The resulting Joule heating depends on the collisional coupling between Saturn's neutral atmosphere and ionosphere, and between the rings and their ionosphere. However, the heating could be as great as 2 mW/m^2.

6) Pryor, Wayne: *Cassini Ultraviolet Images of Saturn's Aurorae*

Wayne R. Pryor, A. Jouchoux, L. Esposito, A. Radioti, D. Grodent, J. Gustin, J.-C. Gerard, F. Crary, D. Mitchell, A. Rymer, and the UVIS Team

Cassini has been obtaining auroral images and spectra of Saturn with the Ultraviolet Imaging Spectrograph (UVIS). We will present highlights of the auroral images, showing a variety of morphologies, including multiple arcs, spiral forms, polar cusp activity, and rotating emission features, some of them pulsating with a roughly 1-hour period. A satellite footprint of Enceladus is occasionally visible.

7) O'Donoghue, James: *On Saturn's 'Ring Rain', Comparison of Results from Years 2011, 2013 and 2014*

James O'Donoghue and Luke Moore

A global-scale interaction between Saturn's ionosphere and ring system was found in April 2011, during Saturn's northern hemisphere spring using the 10-metre Keck telescope. Saturn's ionosphere is produced when the otherwise charge-neutral atmosphere is exposed to a flow of energetic charged particles or solar radiation. At low-latitudes the latter should result in a weak planet-wide glow in the infrared, corresponding to the planet's uniform illumination by the Sun. The observed low-latitude ionospheric electron density is lower and temperature is higher than predicted by models. A planet-ring magnetic connection has been previously suggested in which an influx of water from the rings could explain the lower-than-expected electron densities in Saturn's atmosphere. We reported the detection of a pattern of features in 2011 data, unexpected in the ionosphere, that extend across a latitude band between 25-55 degrees that is superposed on the lower latitude background glow, with peaks in emission that map along the planet's magnetic field lines to features in Saturn's rings. This pattern implies the transfer of charged particles from the ring-plane to the ionosphere. Here we examine new datasets from 2013 and 2014 which have longer integration times than before. We find that either the 'ring rain' water influx is highly variable between different years or that Saturn's low-latitude ionosphere has cooled such that the already weak low-latitude H_3^+ emissions (which are highly temperature dependent) have decreased to below a detectable amount. The latter is supported by evidence that the northern main auroral oval was of the order of 100 Kelvin cooler in 2013 compared with 2011.

8) Koskinen, Tommi: *Temporal and Meridional Trends in Saturn's Thermosphere from Cassini UVIS Occultations*

T. T. Koskinen, B. R. Sandel, R. V. Yelle, I. C. F. Mueller-Wodarg, and D. F. Strobel

We present density and temperature profiles in Saturn's thermosphere retrieved from more than 30 solar and stellar occultations observed by the Cassini UVIS instrument. We find that the exospheric temperature on Saturn increases by 100 - 200 K with latitude from the equator to the poles, ranging from about 370 K to 540 K. This temperature trend implies that the thermosphere is heated at the poles and/or high latitudes, although we find that the meridional temperature gradient is shallower than that predicted by a thermospheric circulation model that self-consistently includes the auroral energy input at the poles (Mueller-Wodarg et al. 2012). We also find evidence indicating that the pressure levels in Saturn's thermosphere expanded at low to mid-latitudes between 2005 and 2010. The observed expansion is likely to arise from enhanced heating of the lower thermosphere during this time period.