index varies from -10 nT to -20 nT, Σ Kp index reached value of 12+). The eclipse was notably exceptional in uniform solar disk. These conditions and fact that the culmination of the solar eclipse over central Europe occurred at local noon are such that the observed ionospheric response is mainly that of the solar eclipse. We provide a full characterization of the propagation of the waves in terms of times of occurrence, group and phase velocities, propagation direction, characteristic period and lifetime of the particular wave structure. However, ionospheric vertical sounding technique enables us to deal with vertical components of each characteristic. Parameters are estimated combining Fourier and wavelet analysis. Our conclusions confirm earlier theoretical and experimental findings, reported in [Altadill et al., 2001; Farges et al., 2001; Muller-Wodarg et al.,1998] regarding the generation and propagation of gravity waves and provide complementary characterisation using wavelet approaches. We also report a new evidence for the generation and propagation of acoustic waves induced by the solar eclipse through the ionospheric F region. Up to our knowledge, this is the first time that acoustic waves can be demonstrated based on ionospheric measurements and analysis. We report similarities in generation and occurrence of acoustic and gravity modes in the eclipsed region. Our analysis techniques enable us to "locate" wave bursts in particular height of ionosphere, specify source region and give characteristics of acoustic and gravity wave movement through ionosphere. Altadill D., J.G. Sole, E.M. Apostolov: Vertical structure of a gravity wave like oscillation in the ionosphere generated by the solar eclipse of August 11, 1999, J. Geoph. Res.-Space Phys., 106 (A10), 21419-21428, 2001. Farges T., J.C. Jodogne, R. Bamford, Y. Le Roux, F. Gauthier, P.M. Villa, D.Altadill, J.G. Sole, G.Miro: Disturbances of the western European ionosphere during the the total solar eclipse of 11 August 1999 measured by wide ionosonde and radar network, J. Atmosph. Solar-Terr. Phys., 63 (9), 915-924, 2001. Muller-Wodarg I.C.F, A.D. Aylward, M. Lockwood: Effects of a Mid-Latitude Solar Eclipse on the Thermosphere and Ionosphere - A Modelling Study, Geoph. Res. Letters, 25 (20), 3787-3790, 1998.

SA21B CC: 519 A Tuesday 0830h

Surface-Boundary-Exospheres in the Solar System I *(joint with A, P, SH, SM)*

Presiding: **A Sprague,** University of Arizona**; M Mendillo,** Center for Space Physics, Boston University

SA21B-01 0830h INVITED

Exploring Mercury's Surface-Exosphere-Space Environment System during the MESSENGER Mission.

William E McClintock[1] (303-492-8407; william.mcclintock@lasp.colorado.edu)

Daniel N Baker[1] (daniel.baker@lasp.colorado.edu)

[1]Laboratory for Atmospheric and Space Physics, 1234 Innovation Dr, Boulder, CO 80803, United States

When MESSENGER begins its four-Mercury-year orbital mission about the planet, it will carry an Ultraviolet-Visible Spectrometer (UVVS), designed to study the composition and structure of the exosphere. The UVVS is one member of a suite of instruments that will provide us with our first comprehensive picture of Mercury's surface-exosphere-space environment system. Also on board the MESSENGER spacecraft are four instruments that will measure surface elemental and mineralogical composition. These are the Gamma Ray Neutron Spectrometer (GRNS), the X-Ray Spectrometer (XRS), the Mercury Dual Imaging System (MDIS), and the Visual and InfraRed Spectrometer (VIRS). In addition, the Energetic Particle and Plasma Spectrometer (EPPS) and Magnetometer (MAG) will measure magnetospheric and pick up ions and a map Mercury's magnetic field respectively. In this presentation we describe the UVVS investigation and how it will contribute to our understanding of Mercury's exospheric processes. We also describe how measurements from UVVS, EPPS, and MAG can be combined with surface composition measurements to provide an overall picture of Mercury's surface-exosphere-magnetosphere interactions and briefly describe our plans for modeling and visualization of the combined data suites.

SA21B-02 0850h INVITED

Sources of the Escaping Lunar Atmosphere Derived from a Decade of Imaging Science Experiments

Jody K Wilson[1] (617-353-7429; jkwilson@bu.edu)

Michael J Mendillo[1] (617-353-2629; mjmendillo@aol.com)

[1]Center for Space Physics Boston University, 725 Commonwealth Ave., Boston, MA 02215, United States

The lunar sodium exosphere owes its existence to the impact of solar photons, solar wind plasma, and meteorites on the lunar surface. Perhaps the most effective methods of testing the effects of each impact process are to make two or more similar observations of the lunar exosphere during periods when the flux of one or more of these agents has changed, or to make a single observation where the effects of different fluxes can be seen simultaneously. We have observed the escaping component of the lunar sodium exosphere under several different sets of conditions. Magnetospheric plasma sputtering was tested during five Full-Moon phase observations in eclipse, where the Moon was in the Earth's magnetospheric plasma sheet three times, and outside of the sheet twice. Multiple observations of the lunar sodium tail at New Moon phase include a unique observation affected by the spectacular 1998 Leonid Meteor shower. Finally, observations near quarter Moon phase show latitudinal variations in solar wind sputtering and/or photon stimulated desorption. In this paper we will summarize the source strengths from each of these mechanisms derived from Monte Carlo simulations studies.

URL: http://sirius.bu.edu/planetary/moon.html

SA21B-03 0910h

Neutral Particle Emission Induced by Solar Wind in Mercury's Environment

Alessandro Mura[1] (mura@ifsi.rm.cnr.it)

Stefano Orsini[1] (orsini@ifsi.rm.cnr.it)

Anna Milillo[1] (anna@ifsi.rm.cnr.it)

Dominique Delcourt[2] (Dominique.Delcourt@cetp.ipsl.fr)

[1]IFSI-CNR, Via del Fosso del Cavaliere 100, Roma 00133, Italy

[2]CETP-CNRS, Saint Maurice des Fossés, France

The peculiar configuration of the Hermean magnetosphere, characterised by a weak magnetic field, may allow a solar wind entrance and circulation in Mercury's environment. More particularly, intense ion fluxes are expected in the cusp regions, which are extremely large if compared to the Earth's ones. In the present study we reconstruct the H+ distribution in space, energy and pitch angle by means of a single-particle Monte-Carlo model. The neutral particle emission induced by the solar wind in the Hermean environment is investigated as well. The H+ are likely to rapidly leave the Hermean magnetosphere or precipitate onto the surface of the planet, thus originating neutral particle emission via ion-sputtering as well as energetic neutral atoms, generated via charge-exchange process. Different external configurations of both interplanetary magnetic field and cross-tail potential drop result in variations of the sputtered and charge-exchange neutral particle signal. The Neutral Particle Analyser - Ion Spectrometer experiment (NPA-IS/SERENA), proposed to fly on board of the ESA mission Bepi Colombo, will monitor the circulating ion and neutral particles. The modeled distributions here presented have been processed in the frame of SERENA instrument and may be considered as a reference tool for the future observations.

SA21B-04 0925h INVITED

Laboratory Studies of Alkali Components in Tenuous Planetary Atmospheres

Boris V Yakshinskiy ((732)445-3351; yaksh@physics.rutgers.edu)

We report on studies performed at the Laboratory for Surface Modification of Rutgers University and focused on the origin of alkali vapors (Na, K) in the tenuous atmospheres of the planet Mercury, the Moon, and Jupiter's icy satellite Europa [1, 2]; we also address the question why alkaline-earth metals (Mg, Ca) are less abundant in the atmospheres. A variety of ultrahigh-vacuum surface science techniques are used, including X-ray Photoelectron Spectroscopy (XPS), Low-Energy Ion Scattering (LEIS), Thermal Programmed Desorption (TPD), Electron- and Photon-Stimulated Desorption (ESD and PSD), Surface Ionization (SI). Measurements have been made on different samples, including the model mineral binary oxide SiO_2 that simulates lunar silicates, and a lunar sample obtained from NASA. Desorption induced by electronic excitations (mainly PSD) rather than by thermal processes is found to be the dominant source process on the lunar surface. The flux at the lunar surface of ultraviolet photons from the Sun is adequate to insure that PSD of sodium contributes substantially to the Moon's atmosphere. A model based on irradiation-induced charge-transfer is proposed to explain the desorption process. There is a strong temperature-dependence of Na ESD and PSD signals from a lunar sample, under conditions where the Na surface coverage is constant and thermal desorption is negligible [3]. On Mercury solar heating of the surface is high enough that thermal desorption will also be a potential source of atmospheric sodium. Ion bombardment of the lunar sample causes both the sputtering of alkali atoms into vacuum and implantation into the sample bulk. In the future we outline the use a novel method, Nuclear Resonance Profiling (NRP) to study the diffusion of alkalis through model minerals, ices, and lunar samples; these measurements would provide additional information to understand the replenishment of Na at the surface of the Moon, Mercury and Europa. We also describe a new detector that we will use to search for desorption of alkaline-earth atoms.

T.E. Madey, R.E. Johnson, T.M. Orlando, Surf. Sci. 500 (2002) 838. [2] B.V. Yakshinskiy, T.E. Madey, Surf. Sci. 528 (2003) 54. [3] B.V. Yakshinskiy, T.E. Madey, Icarus 168 (2004) 53.

SA21B-05 0945h

Sputtering Contribution to Planetary Atmospheres

Raul A Baragiola[1] (+1-434-982-2907; raul@virginia.edu); Catherine A Dukes[1] (+1-434-924-1059; cdukes@virginia.edu); Wen-Yen Chang[1] (+1-434-982-2907; wc9b@virginia.edu); Benjamin D Teolis[1] (+1-434-982-2907; bdt4z@virginia.edu); Ujjwal Raut[1] (+1-434-982-2907; ur5n@virginia.edu); Ricardo A Vidal[1] (+1-434-982-2907; rav4n@virginia.edu)

[1]University of Virginia, Laboratory for Atomic and Surface Physics, Charlottesville, VA 22904, United States

We have measured the sputtering of specific species during ion irradiation of water ice, labradorite, albite, anorthoclase, and olivine targets, to understand the importance of sputtering in the generation of atmospheres around icy satellites of the outer solar system by magnetospheric ions, and around the Moon and Mercury by the Solar wind. We use mass spectrometry in ultrahigh vacuum to measure sputtered species and gas evolved during post-irradiation heating to identify chemical species formed by ion implantation. We will discuss the formation of NO and other molecules in the Saturnian system that may be detectable by Cassini, and the relative importance of different mechanism that lead to the formation of Na atmospheres around the Moon and Mercury.

SA22A CC: 519 A Tuesday 1030h

Surface-Boundary-Exospheres in the Solar System II *(joint with A, P, SH, SM)*

Presiding: **A Sprague,** University of Arizona**; M Cowee,** Institute of Geophysics and Planetary Physics

SA22A-01 1030h INVITED

State of the Art of our Understanding of Mercury's Exosphere

F. Leblanc (33 1 64 47 43 03; francois.leblanc@aerov.jussieu.fr)

Service d'Aeronomie du CNRS, Reduit de Verrieres Le Buisson, Verrieres Le Buisson 91371, France

Mariner 10 is the only spacecraft to have been close enough to observe Mercury's exosphere by UV spectrometry. After the three flybies of Mariner 10, Earth based observations have provided some complementary information on Mercury's exosphere. Thus, the next planed future missions, Messenger and Bepi Colombo should dramatically improve our knowledge of Mercury's exosphere. Therefore up to now, most of the efforts to describe Mercury's exosphere considered only the sodium exosphere, the best known component easily observable from Earth based ground observatory thanks to its strong resonant emission. In this talk, I will describe the particularities of Mercury's surface bounded exosphere due to the length of Mercury's day with respect to Mercury's year, to the strong temperature gradient at the surface from day to night sides, and as a consequence the importance of surface/exosphere interaction, and to its intrinsic small magnetosphere which allows direct solar wind/surface interaction and a particular magnetospheric ion circulation. All these particularities give to Mercury's exosphere its peculiarity. But the most important and up to now most debated point when describing Mercury's exosphere is to properly include all the loss and supply processes of Mercury's exosphere. In the case of the sodium exosphere, several laboratory studies helped modelers to constrain such processes, whereas the present lack of laboratory studies and observations for the other elements supposed to be present in Mercury's exosphere make their study one of the main objective and most promising result of the future planed missions.

SA22A-02 1045h

Europa's Neutral Clouds: Probing the Atmosphere, Surface, and Subsurface

Matthew H Burger[1] ((434)924-4344; burger@virginia.edu)

Robert E Johnson[2] (rej@virginia.edu)

[1]University of Virginia, Astronomy Department, Charlottesville, VA 22903-0818, United States

[2]University of Virginia, Materials Science & Engineering Department, Charlottesville, VA 22903, United States

The existence of a sub-surface ocean at Europa and the possibility of its sustaining life is one of the most exciting scientific questions of our time. Unfortunately, the remoteness of the satellite makes it difficult to study this ocean directly. Studies of the atmosphere and atmospheric escape can provide clues needed for understanding Europa's icy shell and subsurface ocean. The composition and energy distribution of material escaping from Europa are indicative of the interaction between its surface and the local plasma. Observations of this material made from Earth can provide insight into Europa's surface composition and interior and will help determine the capabilities needed for future Europa missions. The discovery of Europa's molecular oxygen atmosphere (Hall et al. 1995) was quickly followed by ground based observations of a sodium exosphere extending more than ten satellite radii above Europa's surface (Brown and Hill 1996). Modeling of this exosphere by Leblanc et al. (2002) indicates that roughly 40% of the material sputtered from Europa's surface escapes forming an extended neutral cloud in orbit around Jupiter. Recent Cassini and Galileo spacecraft observations are suggestive of water products lost from Europa (Mauk et al. 2003, Lagg et al. 2003) and constitute the first observations of Europa's extended cloud. We consider models of the large scale morphology of this cloud which suggest significant morphological differences from the extensively studied Io neutral cloud. We also discuss strategies for confirming these predictions by observing the sodium and oxygen components of the neutral cloud as they extend along Europa's orbit. References: Brown, M. E. and R. E. Hill, Nature, 380, 229-231, 1996. Hall, D. T., D. F. Strobel, P. D. Feldman, M. A. McGrath, and H. A. Weaver, Nature 373, 677, 1995. Lagg, A., N. Krupp, J. Woch, and D. J. Williams, GRL, 30, 10-1, 2003. Leblanc, F., R. E. Johnson, and M. E. Brown, Icarus 159, 132-144, 2002. Mauk, B. H., D. G. Mitchell, S. M. Krimigis, E. C. Roelof, and C. P. Paranicas, Nature, 421, 920-922, 2003.

SA22A-03 1100h

Europa's Neutral Gas Torus

Barry H Mauk[1] (240-228-6023; Barry.Mauk@jhuapl.edu); Donald G Mitchell[1] (240-228-5000; Donald.G.Mitchell@jhuapl.edu); Richard W McEntire[1] (240-228-5000; Dick.McEntire@jhuapl.edu); Chris P Paranicas[1] (240-228-5000; Chris.Paranicas@jhuapl.edu); Edmond C Roelof[1] (240-228-5000; Edmond.Roelof@jhuapl.edu); Donald J Williams[1] (240-228-5000; Don.Williams@jhuapl.edu); Stamatios M Krimigis[1] (240-228-5000; Tom.Krimigis@jhuapl.edu); Andreas Lagg[2] (lagg@linmpi.mpg.de)

[1]The Johns Hopkins University Applied Physics Laboratory, 11100 Johns Hopkins Road, Laurel, MD 20723, United States

[2]Max Planck Institute for Aeronomy, Max-Planck-Strabe, 2, 37191, Katlenburg-Lindau 37191, Germany

In-situ energetic ion measurements from the Galileo spacecraft and remote energetic neutral atom (ENA) images from the Cassini spacecraft have been previously interpreted as revealing an unexpectedly massive torus of gas co-orbiting with Jupiter's moon Europa (Lagg et al., 2003; Mauk et al., 2003). Here we report on the results of detailed modeling of the ENA emission process from the Europa regions. Updates to the distribution and composition of the trapped energetic ion populations are included in the models, as are considerations of the partitioning of the gas products into multiple atomic and molecular species. Comparisons between the models and the Cassini observations reveal a torus with a total gas content equal to (0.5 +/- 0.2) E34 atoms plus molecules. This value is higher than, but within a factor of 3 of, an estimate inferred from a prediction of gas densities derived from Voyager plasma measurements and modeling of the interaction between the plasmas and the gases assumed to be emanating from Europa (Schreier et al., 1993). Lagg, A., N. Krupp, J. Woch, and D. J. Williams, Geophys. Res. Lett., 30, DOI 10.1029/2003GL017214, 2003. Mauk, B. H., D. G. Mitchell, S. M. Krimigis, E. C. Roelof, and C. P. Paranicas, Nature, 241, 920, 2003. Schreier, S., A. Eviatar, V. M. Vasyliunas, and J. D. Richardson, J. Geophys. Res., 98, 21231, 1993.

SA22A-04 1115h

Particle Modeling of the Io Inner Torus Boundary

M M Cowee[1] (mcowee@igpp.ucla.edu)

Y L Wang[1] (ylwang@igpp.ucla.edu)

C T Russell[1] (ctrussel@igpp.ucla.edu)

D A Gurnett[2] (dag@space.physics.uiowa.edu)

[1]Institute of Geophysics and Planetary Physics University of California, Los Angeles, 595 Charles Young Drive East, Los Angeles, CA 90095, United States

[2]Department of Physics and Astronomy, University of Iowa, Iowa City, IA 52242, United States

The Galileo spacecraft passed through the Io torus and its inner boundary on December 7, 1995 and November 5, 2002, during the J0 and A34 passes. Measured plasma densities on both passes indicated a steep gradient at the Io torus inner boundary located between 4.5 and 5 jovian radii (Io is at 5.9 Rj), as well as a much less steep gradient in the outer torus, with a boundary at distances greater than 8 Rj. A simple particle model for Iogenic ion pickup and torus formation developed by Wang et al. (2001) produced an ion distribution which spans distances as far as 0.5 Rj (20 Io radii) away from Io, as was observed by Galileo. Unlike observations, however, the modeled torus inner boundary is not steep and is much closer to Jupiter. It is possible that an outward transport of ions in the inner torus via flux tubes or some other mechanism will steepen the inner torus boundary. We alter the pickup conditions of the Wang et al. model and couple it to a simple radial convection model in an attempt to reproduce the observed inner boundary density gradient and location. In the Wang et al. model, which assumed a background plasma flow velocity at Io equal to the corotation velocity (74 km/s), the ion pickup velocity is 57 km/s. Decreasing the speed of the plasma flow, such that the ion pickup velocity is 20 km/s, is sufficient to move the inner boundary from 3.4 Rj to 4.7Rj.

SA22A-05 1130h INVITED

Surface-bounded Exospheres of the Icy Satellites

Valery I. Shematovich[1] (shematov@inasan.rssi.ru)

Robert E. Johnson[2] (rej@virginia.edu)

John F. Cooper[3] (jfcooper@pop600.gsfc.nasa.gov)

Mau C. Wong[4] (mauwong@jpl.nasa.gov)

[1]Institute of Astronomy RAS, 48 Pyatnitskaya str., Moscow 119017, Russian Federation

[2]Engineering Physics Program and Astronomy Department, University of Virginia , B 103 Thornton Hall, Charlottesville, VA 22903, United States

[3]Raytheon Technical Services Company LLC, SSDOO Project, Space Physics Data Facility, Code 632, NASA Goddard Space Flight Center, Greenbelt, MD 20771, United States

[4]Jet Propulsion Laboratory, California Institute of Technology, Pasadena, CA 91109, United States

Sputtering and radiolysis of the icy satellite surfaces are important sources of neutrals in the Jovian and Saturnian systems [1,2]. We have presented collisional Monte Carlo models of surface-bounded exospheres of the icy satellites in which the sublimation and sputtering sources of H2O molecules and their molecular fragments are accounted for as well as the physical and chemical exchange at the atmosphere-icy surface interface. Products of radiolytic interactions by more penetrating electrons and ions in the volume ice are incorporated into the sublimation source of escaping volatiles. The very tenuous hydrogen and oxygen exospheres originate from a balance between sources from irradiation of the icy satellite surface by solar UV photons and magnetospheric plasma and losses from pick-up ionization and ejection following dissociation or collisions with the low energy plasma ions. The surface-bounded exospheres of the icy satellites are characterized by the hot coronas formed due to atmospheric sputtering, by suprathermal radicals entering the regolith that can drive radiolytic chemistry, and by a supply of pick-up ions and neutrals into the surrounding planetary magnetosphere. This general picture of the surface-bounded exosphere formation is illustrated with calculations of the near-surface oxygen atmosphere of Europa and the supply rate of neutrals to the Europa's near-orbit torus[3]. The surface-bounded exosphere and neutral gas torus provide an extended region for the Jupiter Icy Moons Orbiter detection of neutrals and ions originating from Europa. [1] Johnson, R. E. 2002. Surface boundary layer atmospheres. In Atmospheres in the Solar System: Comparative Aeronomy (M. Mendillo, A. Nagy, J. H. Waite, Eds.) pp. 203-219. Geophys. Monograph, AGU. [2] Cooper, J.F., R.E. Johnson, B.H. Mauk, H.B. Garrett, and N. Gehrels 2001. Icarus 149(1), 133-159. [3] Shematovich, V.I., R.E. Johnson, J.F. Cooper, and M.C. Wong 2004, (submitted to Icarus).

SA23A CC: 220 C-E Tuesday 1330h

Aeronomy Posters

Presiding: **S Basu,** Air Force Research Laboratory**; J A Dodd,** Air Force Research Laboratory

SA23A-01 1330h POSTER

Hot $O(^1D)$ Atoms in the Stratosphere and Mesosphere

Vasili Kharchenko[1] (617 4967536; vkharchenko@cfa.harvard.edu)

Alex Dalgarno[1] (617 4954403; adalgarno@cfa.harvard.edu)

[1]Harvard-Smithsonian Center for Astrophysics, 60 Garden Street, Cambridge, MA 02138, United States

The thermalization of metastable oxygen atoms in the stratosphere and mesosphere has been investigated. Non-Maxwellian $O(^1D)$ distributions have been calculated at altitudes of 25 and 50 km taking into account the energy-transfer and quenching collisions of fast $O(^1D)$ atoms with the ambient gas. The evolution of the energy distributions of nascent metastable oxygen atoms, produced by ozone photolysis, has been determined by solving the time-dependent Boltzmann equation. The time-dependent and steady state $O(^1D)$ distributions have been computed and used for calculations of parameters characterizing $O(^1D)$ thermalization and quenching in the stratosphere and mesosphere. The steady state $O(^1D)$ distributions contain 3 - 5% of non-thermal atoms. These fractions of hot atoms are larger by two to three orders of magnitude than the non-thermal fractions of hot ground state oxygen atoms. The effective temperature of the non-Maxwellian distributions have been found to be 14% and 33% higher than thermal temperatures of the ambient gas at 25 and 50 km. The non-equilibrium rate coefficients and yields of NO molecules in the atmospheric reaction $O(^1D) + N_2$ corresponding to the non-Maxwellian distributions of $O(^1D)$ atoms have been calculated.

SA23A-02 1330h POSTER

Observations of Equatorial Thermospheric Dynamics at Arequipa, Peru, during Magnetic Storms

Michael Faivre[1] (864-656-1427; faivre@clemson.edu)

J W Meriwether[1] (864 656-0915; john.meriwether@ces.clemson.edu)

M A Biondi[2] (412-624-9387; biondi+@pitts.edu)

[1]Clemson University, Department of Physics and Astronomy, 312 Kinard Laboratory, Clemson, SC 29634-0978, United States

[2]University of Pittsburgh, Department of Physics and Astronomy, Pittsburgh, PA 48831, United States

Measurements of thermospheric winds and temperatures were obtained at Arequipa, Peru, during five major magnetic storm periods between 1996 and 2002. The instrument used was a pressure scanning Fabry-Perot interferometer observing at the wavelength of 630

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