this estimate used the solubility for air, not pure oxygen; 2) The gases delivered to the ocean would be at 10MPa and 272 K, this is not a high enough pressure for oxygen hydrate stability, however if the pressure were to reach levels of 11-12MPa then such hydrates would be stable. Once delivered to the ocean, the fate of biologically useful gas hydrates will depend on the density, and hence salinity, of the europan ocean water. If the density of the hydrates exceeds that of the surrounding water and saturation has been reached, then the hydrates will precipitate to the seafloor and form a hydrate sediment. If the hydrates are buoyant in the europan ocean then an accretion layer of hydrates may form at the base of the ice shell. Indeed, such a layer may have implications for ice shell dynamics and evolution.

P51B-0453 0830h POSTER

Formation and Thermal Infrared Spectroscopy of Halite Crusts

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Efflorescent salt crusts form as groundwater evaporates from capillary updraw of brine through sediment. Salts precipitate at the surface, coating and cementing the upper few layers of sediment. If enough brine is present to completely saturate and pond on top of the surface, halite will precipitate at the surface of the brine and settle out as layers of crystalline salt on top of the sediment. In playa environments, salts such as sulfates, carbonates and halides, and forms such crusts. In remote sensing studies of such surfaces, it is important to understand how the presence of salt crusts affects the spectral features of the surrounding sediment. This is especially true when the crusts form from a non-absorbing salt such as halite. Halite has been observed to exhibit unusual spectral properties in the thermal infrared. Specifically, granular mixtures of minerals with halite produced spectra in which the spectral features inverted form reflectivity, shifted to shorter wavelengths and the spectral contrast increased near absorption bands. However, in crusted surfaces, in which the halite cements, coats or overlays the mineral grains, the presence of halite has a different affect on the spectra. This work will examine the precipitation of halite and the formation of salt crusts for several sediment and brine mixtures. Laboratory measurements of thermal emission spectra for the crusts will be compared to previous studies for particulate mixtures of halite with minerals and well as to natural surface crusts. Detailed knowledge of such surfaces will allow for their discrimination and identification in terrestrial playa settings as well as in paleo-environments on Mars.

P51B-0454 0830h POSTER

Ground-based Mid-infrared Observations of Saturn's Rings: Pre-Cassini

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We acquired data at the NASA/InfraRed Telescope Facility (IRTF) from 1995 to 2003 with MIRLIN, a mid-infrared camera at several diagnostic wavelengths in the 8- to 24-μm spectral window. Our observational program has, therefore, covered one fourth of a Saturnian year and followed the progressive march of the rings from their edge-on presentation at the equator in 1995 to their maximum opening, obscuring the northern pole of Saturn. Our specific scientific objectives were to determine the thermal inertia, temperature and opacities of the rings; and thermal asymmetries between the East and West ansae. Our preliminary results indicate that the brightness temperature of the rings peaks near 18 μm. There exists an asymmetry between the East and West ansae of few (2) degrees at low and high ring opening angles. This is similar to the near-infrared albedo asymmetry between the ansae and reflectivities at visible wavelengths. Our current efforts are aimed at modelling the ring opacities in the mid-infrared as function of changes in solar elevation angle, inclination and phase angles of the rings. These models will be validated against previous data sets acquired by Voyager and ISO; high resolution spectroscopic data with GEMINI-N; and SIRTF in preparation for Cassini data to be returned from July 2004.

P51C MCC: Level 1 Friday 0830h

Planetary Atmospheres and Dust Posters *(joint with A)*

Presiding: **H (Wang,** California Institute of Technology**; N O Renno,** University of Michigan

P51C-0455 0830h POSTER

Global Dispersal of Dust Following Impact Cratering Events on Mars

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Hypervelocity impacts on Mars inject dust and vapors into the upper atmosphere. If the particles derived from the projectile or surface are widely distributed, impact events could drive intense weather patterns and perhaps transient climate change on Mars [Segura et al., *Science* (2002)]. Recent work on small impact events (100 m-sized projectiles) find that the mass of dust stirred into the troposphere may be equivalent to global dust storms [Nemtchinov et al., *JGR* (2002)]. For ~10 to ~100 km-sized impactors, dust and greenhouse vapors may be delivered to the upper troposphere and lower stratosphere, where the long residence time has the potential for regional or perhaps even global effects on the weather. In this work, we investigate the transport mechanisms that control the dispersion of dust injected into the upper troposphere from large impact events using a high-resolution global atmospheric dynamics model [Cho & Polvani, *Science* (1996)]. The spreading rates, dispersal extent, and the potential for weather and climatological perturbations from both large (~10 km) and giant (~100 km) impactors are studied. The overarching goals in this study are to identify locations of persistent concentrations of aerosols and to estimate the smallest impact which may generate transient rainfall on Mars. From our simulations we find that modeling of the climatological response from giant, basin-forming events may assume nearly homogeneous aerosol distribution. However, understanding the atmospheric response to the more frequent, smaller cratering events requires explicit treatment of the spatial inhomogeneities caused by the atmospheric motion. Hence, 2-D or 3-D atmospheric models are needed. Intriguing flow concentrations in the southern hemisphere, which could serve as locations for storm fronts, are observed following large impacts over a wide range of conditions.

P51C-0456 0830h POSTER

Numerical Simulation of Martian Global Dust Storms and the Dust Cycle

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We investigate the triggering, growth, decay and the inter-annual variability of global dust storms (GDS) on Mars. To date, testing of various theories of GDS initiation and variability has been limited by inability to numerically simulate spontaneous, variable storm development from realistic pre-storm model states. Here we describe General Circulation Model simulations that generate spontaneous and variable GDSs from realistic background conditions. Modelled GDSs produce dramatic increases in atmospheric dustiness, global-mean air temperatures, and atmospheric circulation, in accord with observations. The simulations generate global storms in southern spring and summer with significant inter-annual variability in size and timing of occurrence, including years with no storms. We propose a simple explanation for the observed dust cycle on Mars from our simulations. Stresses associated with large-scale (>300 km) wind systems initiate the large storms. Explosive growth results from the intensification of the Hadley circulation and the activation of secondary dust lifting centers. Away from great storms, the annually repeatable cycle of atmospheric temperatures and dust opacities observed in northern spring and summer is a result of convective (dust devil) lifting.

P51C-0457 0830h POSTER

Vortex Dust Flux: Experimental Results Comparing Terrestrial and Martian Cases

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Evidence for active aeolian processes (dunes, wind-streaks, ripples, dust storms, and dust devils) on Mars have been observed by Viking, Mars Global Surveyor (MGS), Mars Pathfinder (MPF), and Mars Odyssey. Dust devils on Mars, as on Earth, are seasonally dependent and are very common in some areas, leaving both bright and dark streaks in their wakes demonstrating their ability to modify the surface. Previously, experimental work demonstrated that the dust lifting mechanism, predominantly the pressure drop (ΔP) in the dust devil core, is more efficient at lifting dust than boundary layer winds. The amount of dust that is lifted via the ΔP-mechanism (dust flux) is not well understood for Earth or Mars. This study aims to develop that understanding through experiments with the Arizona State University Vortex Generator (ASUVG) at both Earth-ambient (~1000mb) and Mars (~10mb) conditions using physical analogs for martian dust (particles ~2μm in diameter). The ASUVG generates dust-devil-like vortices through a motor-driven blade assembly positioned over a configurable test bed. Currently flux experiments have included a removable test plate that rests on an in situ balance used to measure the dust mass loss as a function of time for a ~5mm-thick bed of dust settled by suspension. Preliminary results have given lower limits on dust devil dust flux for terrestrial (~1-2 g/m^2/s) and martian (~2-4 g/m^2/s) conditions. Martian conditions yield fluxes that are ~1.5-2.0 times that of the analogous terrestrial cases. The terrestrial results are comparable to field observations made by Metzger (1999) in Eldorado Valley, NV, demonstrating the validity of using the ASUVG. Future studies intend the usage of optical systems to relate suspended dust opacity to mass in order to expand the range in sizes and speeds of vortices examined.

P51C-0458 0830h POSTER

Modeling Electrostatic Discharges Near the Surface of Mars

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Due to the prevalence of Martian dust devils and dust storms, an understanding of the underlying physics of electrical discharges in Martian dust is critical to future Mars exploratory missions. Mars's low atmospheric pressure and arid, windy environment suggest that the dust near the surface of Mars is more susceptible to triboelectric charging than terrestrial dust. When dust particles come into contact, charge can be transferred between the grains. Wind-driven dust studies (Stow, 1969) show that in the case of particles with identical compositions, the particle with the larger radius in a collision preferentially becomes positively charged. Upwinds within a dust cloud can carry the lighter, negatively-charged particles to higher altitudes. The stratification of particle sizes causes an electric dipole to form. When the electric potential within the cloud exceeds the breakdown voltage of the surrounding atmosphere, a discharge occurs. We have

created a simple theoretical model to examine the creation of discharges due to triboelectric charging near the surface of Mars. The model results are compared to our laboratory experiments which demonstrate that discharges can be created via vertical charge separation in a simulated Martian environment. When JSC-Mars-1, a Martian regolith simulant, is vertically dropped in a low-pressure CO2 atmosphere, electrical discharges are both visibly and electronically detected. Measurements of the frequency and intensity of these discharges show that they can occur under conditions expected on the Martian surface. This work is supported by NASA Space Science GSRP, NGT5-50345.

P51C-0459 0830h POSTER

Electrical Discharges and Broadband Radio Emission by Martian Dust Devils and Dust Storms

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Triboelectric charging of saltating and colliding sand and dust particles produces strong electric fields in terrestrial dust devils and dust storms. Acceleration of the charged particles, as well as microdischarges between them, generates wideband electromagnetic radiation that may be easily detected by properly designed radio receivers. Similar phenomena are expected to be ubiquitous on Mars, because Martian dust devils and dust storms are larger, stronger, dustier and more frequent than their terrestrial analogues, and electrical discharges occur at a much lower potential gradient in the thin Martian atmosphere. We present theoretical arguments and show observational evidence that Martian dust events produce nonthermal wideband electromagnetic radiation that is strong enough to be detected from Earth.

P51C-0460 0830h POSTER

Cloud-tracked winds for the first Mars Global Surveyor Mapping year

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We have measured winds using cloud motion in consecutive Mars Global Surveyor (MGS) Mars Orbiter Camera (MOC) wide-angle global map swaths taken during the first mapping year (Ls 135°-360°-111°). We present a total of 11,200 wind vectors collected in the north polar region during Ls 135°-195° (late summer/early fall) and Ls 20°-55° (mid spring), and in the south polar region during Ls 337°-10° (late summer/early fall). For cases with good coverage, we also present the derived mean zonal and meridional winds and the circulation pattens. The speed of the zonal winds in 60°N-70°N increases at 0.6 m/s/$^\circ$Ls in late northern summer, and that in 60°S-70°S increases at 0.7 m/s/$^\circ$Ls in late southern summer. The latitudinal distribution of zonal wind within 50°N-75°N from mid northern summer to early northern fall indicates that winds at higher latitudes are generally weaker than those at lower latitudes, but the rate of increase with time is faster at higher latitudes. There is a cyclonic gyre in the 90°W-0°-30°E sector in the north polar region. The cloud-tracked winds in the north are compared with the winds simulated by the GCMs and with the gradient winds derived from MGS Thermal Emission Spectrometer (TES) data.

P51C-0461 0830h POSTER

Mars Atmospheric Phenomena Observed During the 2001 Planet Encircling Dust Strom

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The Mars Global Surveyor produced data that coincided with the 2001 Planet Encircling Dust Storm. This global dust storm occurred during southern spring, and data were captured from the Mars Orbital Camera (MOC), the Thermal Emission Spectrometer (TES), the Mars Orbiter Laser Altimeter (MOLA), and the Mars Horizon Sensor (MSH). We are in the process of synthesizing these data sets to better understand the processes controlling the growth and decay of global dust storms. Here we report the results of our efforts with the MOC and TES data. These data have been analyzed for the entire period of the dust storm, and include temperatures, opacities, and images. Malin Space Science Systems provided us the MOC red-filtered wide angle global mosaics that show the entire planet every sol for the duration of the storm. We then superimposed on these daily images TES 0.5 millibar temperature data and 9-micron dust opacities. Combining these two datasets and animating them allows us better visualization of the storm and related atmospheric phenomena during this period. Dust lifting and transport are clearly visible and certain general circulation patterns are easily identified.

P51C-0462 0830h POSTER

Predictions of a Global Climate Change and Cycle on Jupiter

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We predict that most of Jupiter's large vortices, similar to (but not including) the Great Red Spot, will soon disappear due to vortex mergers. This will cause global temperature changes of $\sim 10^\circ$K. Within a decade, several of Jupiter's westward jet streams (there are 12) will form waves. They will grow, break, roll-up and re-populate Jupiter with new vortices. These dynamics should be visible from earth as the break-up of a circumferential band of clouds into "spots". The new vortices will be similar to those that were observed during most of the 20^{th} century. For $\sim$60 years they will change only slowly, then abruptly bunch together. Shortly afterward, most will disappear by merging with other vortices. The cycle described above will repeat with a $\sim$70-year time scale, with many of the events detectable from earth or by satellite. The formation of the White Oval "spots" in 1939 began the current global climate cycle, and their mergers in 1997–2000 signaled the beginning of its end. Our predictions are based on fundamental vortex dynamics rather than global circulation models.

P51C-0463 0830h POSTER

Retrieval of Composition of Jupiter's Atmosphere From Passive Microwave Sounding

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Passive sounding of Jupiter's atmosphere at wavelengths between 1-100 cm may be a possible technique for retrieving compositional information from orbiting spacecraft to depths corresponding to hundreds of bars pressure. The Solar System Exploration Decadal Survey has recommended such sounding for a future Jupiter Polar Orbiter Probe mission. We assess the sensitivity of retrieved atmospheric composition in the spectral region 1-100 cm to several parameters, including: spectral line shapes and widths of ammonia and water at high pressures and temperatures, thermal structure of the atmosphere, non-ideal gas effects in the gaseous equation of state, elemental abundance uncertainties, cloud dielectric properties, pressure depth to which the retrieval algorithm extends, and influence of ionization of, for example, alkali metals at high temperatures in the deepest portions of the retrieval region.

P51C-0464 0830h POSTER

Passive Microwave Sounding of Jupiter's Atmosphere From an Orbiting Spacecraft

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The brightness temperatures of Jupiter at wavelengths from 1 to 100 cm provide important constraints on the distribution of microwave opacity in the Jovian atmosphere. At Jupiter, these wavelengths probe the atmosphere between 1 and 1000 bars. The microwave opacity is most sensitive to the gaseous ammonia and water abundances as functions of height and location on the planet but other sources of opacity may also be present. It is difficult to determine a precise water abundance from nadir measurements alone because of the dominating absorption due to ammonia in the upper atmosphere. Even if the physical properties of the atmosphere were known precisely and the absorption properties of all of the absorbers were known, radiometer noise and calibration limitations will set limits to the accuracy at which the ammonia and water can be retrieved. We examine in this paper the impact of including the relative brightness of nadir and off-nadir views, which can be known much more precisely than the absolute brightness. This greatly improves the ability to measure simultaneously the water and ammonia abundances on Jupiter, relying on the fact that water and ammonia have different altitude distributions due to their different vapor saturation laws. We will also discuss how differential measurements from place to place on the planet can be used to constrain the ammonia and water abundances.

P51C-0465 0830h POSTER

Characteristics of Saturn's Atmosphere from Ground-Based Thermal Infrared Remote Sensing

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Several years of observations of Saturn, obtained primarily at NASA's Infrared Telescope Facility, establish a baseline against which data from the Cassini Composite Infrared Spectrometer (CIRS) and other remote-sensing instruments can be compared. Thermal emission at 5.2 μm, sensitive to clouds near and above the 2–3 bar level, finds them to be strikingly inhomogeneous with large zonal variations near the equator and 45°S. At longer wavelengths, stratospheric temperatures near 10 mbar are sensed by 7.85-μm CH_4 emission and (with C_2H_6 abundance variations sensed by 12.2 μm C_2H_6 emission). Trosospheric temperatures near 100–400 mbar are sensed by H_2 collision-induced emission between 17 and 24 μm. Strong seasonal forcing of stratospheric temperatures is evident, with temperatures tracking the insolation variations

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with little time delay, inconsistent with purely radiative equilibrium condistions. Stratospheric temperature (or C_2H_6 abundance) peaked sharply poleward of 81°S latitude in a high-resolution Keck image in 1998. Meridional variations of stratospheric and tropospheric temperature are not strongly correlated with one another. Planetary-scale zonal waves as large as 1 Kelvin amplitude are seen in the stratospheric temperature field, with some evidence for even larger-amplitude waves in the troposphere. Similar to vortices in Titan and Jupiter, we might expect Cassini to detect a polar vortex (*e.g.* a region of depressed temperatures with a sinusoidal boundary), if driven by the seasonal loss of insolation poleward of its arctic circle. This work was supported by funds from NASA to the Jet Propulsion Laboratory, California Institute of Technology and the Goddard Space Flight Center. Brett Beach-Kimball was supported by the Undergraduate Student Researcher Program (USRP); Brian Jackson was supported by JPL as a Caltech Summer Undergraduate Research Fellow.

P51C-0466 0830h POSTER

Representing Planetary Atmospheric Structures and Observables with Radio Occultation Transform Pairs

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Current methods for relating radio occultation observables (the bending angles) to the refractivity profile of a planetary atmosphere require significant numerical integration. Although accurate and valid, this approach does not clearly illustrate how changes in refractivity, based on physical parameters such as temperature, pressure, or number density, relate to changes in the observed bending angles, and vice versa. However, the radio occultation Abel transform does have one known transform pair directly relating refractivity to bending angle, as derived by Eshleman (1973). The radio occultation transform pair has the potential to allow direct understanding of how changes in atmospheric refractivity and the observed bending angles map to each other. The complete analytical form of the radio occultation transform pair is complicated, in part because the radio occultation Abel transform includes ray bending effects. However, it can be written out in terms of a series expansion. Assuming certain common atmospheric conditions, such as a thin atmosphere, allows significant simplification by keeping only a few terms of the series and does not affect the validity of the representation (Eshleman, 1996). These simplifications allow representation of atmospheric refractivity structures in terms of power law expressions with controllable constants that map directly to the observed bending angles. We evaluate the superposition of several power law refractivity terms to represent atmospheric structures for both thin and thick atmospheres, the errors introduced in the refractivity profiles at different levels of simplification, and make initial observations of how physical differences in a planetary atmosphere, expressed in terms of refractivity, map to changes in the observed bending angle. The radio occultation transform pair approach allows us to better understand how differences in the refractivity structure of a planetary atmosphere relate to changes in radio occultation observables, without numerical integration.

P51D MCC: Level 1 Friday 0830h

The Young Solar System I Posters
(joint with NG)

Presiding: **Y Nakagawa,** Kobe University

P51D-0467 0830h POSTER

General Circulation of the Transiting Exoplanet, HD209458b

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Showman and Guillot 2002 (A&A, 385, 166S) presented preliminary numerical simulations of the meteorology of HD209458b's atmosphere in the radiative region using the EPIC model of Dowling et al. 1998 (Icarus 132, 221). Their simulations reveal that the intense radiation of the star sustains a steady temperature difference between the day and night sides of the planet. In steady state, the models predict strong eastward equatorial jets. The magnitude of the day-night temperature difference depends on the radiative transfer of the upper atmosphere, the physics of the deep atmosphere at the interface with the planet's fully convective interior, and the effects of winds. We will present improved, higher resolution three-dimensional models of the general circulation of HD209458b. Day-night temperature variations and winds are potentially observable both in the infrared light curve of the planet, if it can be measured, and in the planetary albedo, which is likely to be variable across the planet's surface due to variations in upper atmospheric chemistry and cloud formation.

P51D-0468 0830h POSTER

A Planetesimal Accretion Zone in a Circumbinary Disk.

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Until recently, it had been believed that only single solar-type stars might harbor planetary systems. On the other hand, circumbinary disks have been detected by mm/sub-mm wavelength observation. Planets may be formed also in such disks. We investigate the conditions for planetesimal accretion in a circumbinary disk. The binary system gives stronger gravitational perturbation against planetesimals orbiting nearer to the binary. Therefore, the relative velocities between planetesimals will be larger, and when they exceed the escape velocity, it is impossible for the planetesimals to accumulate into a planet. We perform long-term numerical integrations of binary and planetesimal orbital motions, and find the upper limit of planetesimal semimajor axes where the velocity dispersion of the planetesimals exceeds the escape velocity. That is, when the binary semimajor axis is set to 1 AU, the eccentricity to 0.1 and the total mass to 1 $M_\odot$, the planetesimals are prevented from accreting when they orbit in a zone within 13 AU from the barycenter of the binary system. In regions outer than 13 AU, planetesimals can accrete. We also derive an analytic expression of the eccentricity of a planetesimal excited by the gravitational perturbation of the binary.

P51D-0469 0830h POSTER

No Evidence for Trapped Noble Gases in CAIs

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Refractory inclusions (CAIs) in meteorites probably are the first solids in the solar system. Although formed at high temperatures, CAIs are reported to contain trapped noble gases [1,2,3] which would provide information on CAI formation and solar system evolution. We reassessed this question by measuring Ne and Ar in CAIs of primitive chondrites (Allende, Axtell, Efremovka) by IR-laser extraction suitable for measuring low gas concentrations [4]. We chose meteorites with different preatmospheric radii, exposure ages, and degrees of alteration to take into account those effects on CAI noble gas compositions.
$^{20}Ne/^{22}Ne$ is below 0.9 indicating the absence of common trapped Ne. We suggest that elevated $^{20}Ne/^{22}Ne$ of [1,2,5] resulted from contamination of their CAI samples with matrix rich in trapped Ne. $^{21}Ne/^{22}Ne$ is 0.72 to 0.86; more altered CAIs show the lower ratios. The Ne might be a mixture of chondritic cosmogenic Ne and nearly pure ^{22}Ne, e.g., from presolar SiC [3]. However, calculated cosmogenic Ne for CAI minerals perfectly mimics the observed trend; in particular Na-rich alteration phases shift the $^{21}Ne/^{22}Ne$ to lower values. $^{36}Ar/^{38}Ar$ is 0.7 to 4.8, thereby more altered CAIs have higher ratios. The Ar might be a mixture of chondritic cosmogenic Ar (mainly produced from Ca) and trapped Ar [3] or solar wind Ar [2], the latter supporting CAI formation in an X-wind scenario [6]. However, due to high Cl concentrations in CAIs also nearly monoisotopic ^{36}Ar produced cosmogenically by neutron capture and beta- decay on Cl must be taken into account. Modelling Ar ratios and concentrations using only cosmogenic Ar from Ca and Cl nicely match the measured data. Thereby more Cl-rich altered CAIs show higher $^{36}Ar/^{38}Ar$.
Although the data do not principally contradict the presence of trapped Ne or Ar in CAIs they can be straightforwardly explained by cosmogenic productions mainly from Na, Ca, and Cl.
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Consideration of formation process for the nuclei on precursor

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The very isotropic microwave background and the Hubble expansion indicate that the universe has evolved from an earlier state of high temperature and density that can be reasonably well described by Friedman-Lemaitre-Robertson-Walker cosmological models. The nuclear evolution of non-degenerate matter expanding from very high temperature was studied in detail for various values of the expansion rate and of the proton-neutron abundance difference and baryon density[1,2,3]. In this calculation, many nuclear reactions were included, and its results suggested important reaction process for the evolution of nuclear abundances. 3He and 4He are very important elements in these nuclear reactions as the primordial nucleosynthesis. Microscopic study for few body system is one main topic in nuclear theoretical physics. In this field, very accurate calculations are available by using the Faddeev equations[4]. Recently, many data for pd, p-3He and d-3He have been obtained including polarized observables. Model calculations for systems including 3He and 4He (for example, d + 3He → p + 4He) are carried out using the Faddeev equations based on the meson exchange models[4]. This model reproduces well the empirical phase shifts which are determined by so-called phase-shift analyses using all of available scattering data measured at various laboratories around the world[5,6,7]. Constructions of models for the nuclear reactions including 3He and 4He will give important information for calculations of the primordial nucleosynthesis after big-ban. The calculations are carried out until the sum of the abundances at each mass number ceases to change. Various different set of initial conditions for the baryon mass density, the expansion rate and the neutron-proton ratio are used. Dusts kept in precursor asteroid nebular form precursor asteroid, then, formations of planet start [8]. Possible values of parameters in the initial conditions for theoretical calculations will be searched considering an information from precursor asteroid References:
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The Asteroid Impact Hazard: Moving Beyond Spaceguard *(joint with PA)*

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An Updated Assessment of the Hazard Due to Earth Impacts

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