5) initiating distributed data bases where cognizant investigations and institutions have responsibility for long term maintenance and supportive utilization. NASA has formed a small Definition Team to examine the pathways and realistic goals of such an endeavor. The initial efforts of this team will be described as well as the content of the program as presently conceived. Even if only partially successful, this program should make spaceflight data significantly more accessible to all interested scientists and promote the synthesis of information from problems considered too complex in the past.
*Part of this work was performed under NASA Contract NAS 7-100.

temperatures, however, are difficult to reconcile with plausible models for the formation of the solar system. Sufficient energy was available to heat the nebula to high termperatures during gravitational collapse, but the collapse is thought to have been slow enough that most of this energy would have been lost by radiation.

The REE patterns fall into groups which appear to have been isolated from the nebula at similar temperatures. Samples of intermediate isolation temperature appear to be completely absent. Apparently, Allende either sampled a few discrete regions in a nebula with a continuous change in isolation temperature, or material became isolated in batches with discrete temperature steps between the isolation. The mechanisms responsible for such processes are unknown.

Special Public Session 5
Planetary Science and Public Policy
(Michael J. S. Belton, Moderator)
8:30 p.m. (Ballroom)
(co-sponsored by the Planetary Society)

WEDNESDAY, 20 OCTOBER 1982
Morning Session 6
The Origin and Evolution of the Solar System
(Patrick Cassen, Moderator)
8:30 a.m.–10:10 a.m. (Ballroom Partition A)
(in parallel with Morning Session 8, except for Invited Review)

Invited Review

6.1 Chemistry of the Early Solar System. W. V. BOYNTON, Univ. of Arizona. - In this talk I shall concentrate on the earliest stages of condensation, which occurred at high temperature. Some of the strongest evidence for high-temperature events was first found in Ca,Al-rich inclusions in the Allende meteorite. Most of these inclusions contain a large number of refractory trace elements which are uniformly enriched to nearly 20 times the level found in CI chondrites (Grossman, 1973, GCA, 37:1119). The enrichment appears to be independent of all geochemical properties except the low vapor pressure.

The enrichment by a factor of 20 suggests that 95% of the mass of the condensible elements found in CI chondrites were too volatile to condense at these high temperatures (on the order of 1300 K). More direct evidence for high temperatures were found in a subset of the Ca,Al-rich inclusions in which the rare-earth elments (REE) have a peculiar enrichment pattern which is not a smooth function of atomic number. Although these irregular patterns were previously unknown in any sample from the earth, moon, or meteorites, they were found to be just as expected for condensation from the solar nebula at high temperatures (Boynton, 1975, GCA, 39:569). The patterns provided strong evidence that most of the REE were previouly in the gas phase; thus high temperatures (~1400 K) were present. The high

6.2 The Chemical Composition of a Possible Proto-Solar Nebula, W. M. IRVINE, U. Mass. - That comets consist of condensed interstellar volatiles and grains is suggested by several lines of evidence, including models of coma chemistry, anomalous noble gas isotope ratios in meteoritic organic matter, and the possible presence of carbynes in both carbonaceous chondrites and interstellar clouds. Recent evidence indicates, however, that even those interstellar clouds with similar physical properties may exhibit striking differences in chemical composition. As a result, more accurate determination of the chemical composition of molecular clouds may improve our knowledge of the composition of cometary nuclei, while improved understanding of cometary chemistry will help determine the type of interstellar region in which the Sun was formed, and therefore set constraints on the composition of the solar nebula.

We describe here recent measurements of relative molecular abundances in the nearby cold, dark interstellar cloud TMC-1, which has been called a "proto-solar nebula". In particular, the relative concentration of HC_3N and increasingly more saturated analogs is presented, including the first interstellar detection of methylcyanoacetylene.

6.3 Tidal Barriers and the Viscous Evolution of the Solar Nebula. K. HOURIGAN and W.R. WARD, JPL, CALTECH - At some stage, the gaseous solar nebula from which the planetary material condensed was dissipated. The presence of large mantles of solar-composition gas on Jupiter and Saturn implies that accretion of these bodies took place before the nebula was fully cleared. A possible mechanism proposed for the dispersal of the nebula disc has been that of internal viscous stresses, which allow the gas to transport angular momentum outwards. The corresponding loss of energy stored in the shear results in an ever-increasing fraction of the disc material falling in towards the primary. Ignoring concomitant changes in the nebula, it has been shown that asymmetries in the tidal torques exerted by even a 'minimum-mass' nebula on a Jovian-size body may lead to a variation of the planet's semi-major axis on a time-scale $\lesssim O(10^4)$ years (P. Goldreich and S. Tremaine, 1980 Ap. J. 241, 425), although the direction of motion and the ultimate orbital fate of the planet are left uncertain. If the viscous stresses in the disc are not too great, a large enough planet can clear a tidal-zone around its orbit, thus providing temporary orbital stability. However, we show that the establishment of a tidal barrier to the flow of nebula material results in the planet's own angular momentum becoming locked into the transport processes in the evolving disc. Irrespective of the form of viscosity law considered, the constraint of conservation of the system's angular momentum leads almost invariably to substantial orbital drift of the planet. (K.H. supported by a NASA/NRC Associateship.)

6.4 Nonisothermal, Axisymmetric Models of the Presolar Nebula. A. P. BOSS, Dept. Terr. Mag., Carnegie Inst. Wash. - One scenario for formation of the presolar nebula involves the collapse of a solar mass-sized cloud with low angular momentum J. Such a cloud must enter the nonisothermal regime without fragmenting into a binary star system if it is to be a candidate for the presolar nebula. Self-gravitating, gas hydrodynamics computer codes in 2D (axisymmetry) and 3D have been developed, with radiative transfer in the Eddington approximation, allowing calculations to be made in the nonisothermal regime. The 2D code is used for preliminary exploration of parameter space (e.g., relative amounts of thermal, rotational, and gravitational energies; total mass M; opacity), prior to use of the 3D code. The gas is taken to be inviscid, to learn whether or not presolar nebula formation is possible without invoking turbulent viscosity.
The first sequence of models attempts to discern how low a value of J/M is required to avoid ring formation in 2D (which would imply binary formation in 3D). A series of models with J/M ranging from 1(19) cm^2 s^{-1} (Safronov 1980) to 4(20) (Cameron 1978) shows that clouds with J/M $\gtrsim$ 2(20) form rings shortly after entering the nonisothermal regime and reaching a quasiequilibrium state in their optically thick inner regions. Clouds with J/M $\lesssim$ 2(19) do not form rings shortly after reaching this state. The latter models are being continued to ascertain if ring formation occurs during the accretion and contraction phase or during the later H_2 dissociation and collapse phase.

6.5 Initial Sizes of Planetesimals. S.J. WEIDENSCHILLING, R. GREENBERG, Planetary Science Inst. -- The usual scenario for planetesimal formation is gravitational instability of a dust layer in the solar nebula (Safronov, NASA TTF-677, 1972; Goldreich and Ward, Ap. J. 183, 1051, 1973). Instability occurs at a critical density $\rho_c \simeq 3\ M_\odot/2\pi R^3$; the characteristic wavelength yields planetesimals of mass $m_p \sim (6\pi/\rho_c)^2 \sigma_s^3$, where σ_s is the surface density of the layer. It is usually assumed that σ_s represents the entire local content of solids in the nebula, and the planetesimals are of uniform size. This is the case only if settling causes homologous thinning of a uniform dust layer, i.e., all grains are identical. If coagulation occurs, larger grain aggregates experience runaway growth and rapid settling, forming a dense sublayer in the central plane. Our numerical simulations indicate that this sublayer may become unstable while it contains <1% of the total mass of solids. The resulting planetesimals are correspondingly smaller; actual sizes depend on the rate mass arrives at the central plane relative to the growth time of instabilities (~ the orbital period). Gravitational encounters among this first generation of planetesimals stir them out of the plane, but their perturbations do not affect later-settling dust which is damped by gas drag. The process may repeat for several generations, while collisional accretion proceeds. It is unlikely that this process would yield planetesimals of uniform size.

6.6 Formation of Comets Among the Outer Planets. R. GREENBERG, S.J. WEIDENSCHILLING, C.R. CHAPMAN, D.R. DAVIS, W.K. HARTMANN, PSI -- A candidate region for comet formation is the zone of Uranus and Neptune, planets considered to have grown from comet-like planetesimals before scattering the remainder to the Oort cloud and beyond. Accretion models (e.g. Safronov's) applied to the outer solar system without ad hoc assumptions have tended to require $\sim 10^{11}$ yr for planet growth. Our simulation of planet growth in the inner solar system from planetesimals originally produced by gravitational instabilities (Icarus 35, 1, 1978) gave much faster growth than Safronov's ($\sim 10^2$ to 10^3 times faster during the stage in which a substantial planetary embryo is produced) and left a substantial number of planetesimals near the original size, with a power-law distribution of even smaller debris. Qualitatively, such a simulation applied to the outer solar system might be expected to yield (1) the planets in reasonable time and (2) an adequate residue of comet-sized (~1 to 10 km) bodies to later populate the Oort cloud. In fact, in our model, outer planet embryos do grow rapidly, but an accompanying comet-like size distribution can remain only if the initial population was comet-like (as seems possible according to the new disk settling model by Weidenschilling, this meeting). If the initial planetesimals are taken as predominantly ~100 km in radius (in accord with gravitational instabilities in a flat disk of minimal surface density ~0.5 gm/cm), or even as small as ~10 km, insufficient debris survives in the cometary range, because such weak icy material is rapidly broken into even smaller pieces. Even if the population initially includes many comet-sized bodies, a comparable initial mass of 100 km bodies would stir velocities enough to grind away the smaller bodies, without providing sufficient debris to replace them. Comets are probably the residue of the initial population of planetesimals in the outer solar system, not fragments of larger bodies.

6.7 The Explanation of Bode's Law and its Applicability, J.B. DAVIES, CIRES, University of Colorado - Self-gravitating gaseous discs are constructed to yield asymptotic density solutions for various rotation parameters and equations of state. The disc is composed of spherical central bulge and a flat outer disc. Ring perturbations in pure gas discs have wavelengths too long to yield more than a few density maxima along the equatorial plane. For dust-gas discs, however, the distance