THE COMET RENDEZVOUS ASTEROID FLYBY MISSION: A STATUS REPORT; Paul Weissman and Marcia Neugebauer, Jet Propulsion Laboratory, Pasadena, CA 91109.

The Comet Rendezvous Asteroid Flyby mission received a New Start in fiscal year 1990. CRAF will match orbits with an active short-period comet and follow it around the Sun, making scientific measurements of the nucleus, coma, and tail. The Imaging system will map the nucleus surface at a resolution of 1 meter/line-pair or better, while VIMS and TIREX will produce spectral and thermal maps of the surface. Onboard instruments will collect cometary dust, ice, and gases and perform elemental and molecular analyses. A suite of fields and particles instruments will observe the solar wind interaction with the cometary atmosphere and tail. Radio tracking of the spacecraft will provide an accurate measure of the nucleus mass and higher harmonics in the comet's gravity field. En route to the comet, the spacecraft will make a close flyby of a large asteroid, preferably a primitive type from the outer main belt. Observations at the asteroid include remote sensing mapping of the surface, detection of any solar wind interaction observable at the flyby distance, and measurement of the asteroid mass to better than 10% accuracy.

Detailed design of the CRAF spacecraft is currently underway at JPL. Recent mass growth has necessitated a switch to Venus-Earth gravity assist type trajectories, similar to that used by the Galileo spacecraft. These trajectories require longer flight times from launch to rendezvous with the target comet. The details of the current baseline mission, spacecraft design, and instrument payload will be reviewed. CRAF is a joint project of the space agencies of the United States, Germany, and Italy.

Reference: Neugebauer, M., and Weissman, P. R., The CRAF Mission, *EOS* **70**, 633, 1989.

RUNAWAY PLANETESIMAL GROWTH SUGGESTS A NEW MODEL FOR THE FORMATION AND ACCELERATION OF THE ASTEROIDS. G.W. Wetherill, DTM, Carnegie Institution of Washington, Washington, D.C. 20015 U.S.A.

Quantitative models of the growth of planets from 1 to 10 km planetesimals predict a first stage of runaway growth to form $\sim 10^{26}$g planetary embryos on a time scale of 10^4–10^5 years in the terrestrial planet region (1,2). A decrease in surface density with semi-major axis (a) proportional to $1/a$ then also predicts growth of larger (3 to 6×10^{26}g) embryos at the distance of the present asteroid belt on a time scale of 10^5 to 10^6 years. In the absence of any other assumed effects, these embryos will coalesce to form at least one Earth-size planet in the asteroid belt, contrary to observation.

It is commonly proposed that this problem can be avoided by preemptive complete formation of Jupiter on a similar $<10^6$ year time scale, suppression of asteroidal runaways by long range Jovian perturbations and subsequent acceleration and collisional destruction of asteroid-size bodies (e.g. 3,4). As yet, no quantitative calculations have been presented that support all the required features of this hypothesis. It appears, in fact, that severe problems arise in extending this hypothesis to deplete the region between 1 and 2.3 A.U., because of both the shorter time scale and the relative weakness of Jupiter perturbations in this region. A quantitative attempt to remove the problems in this intermediate distance region has had only moderate success (5).

The present calculations support a suggestion that this difficulty can be eliminated by assuming that runaway embryos actually formed in the asteroid belt, at least out to 3.3 A.U., followed by relatively leisurely formation of Jupiter on a 5 to 10 m.y. time scale. It is found that following the formation of Jupiter, mutual perturbations between embryos random walk them into Jovian commensurability resonances, leading to large chaotic fluctuations in eccentricity. In this way material is removed from the asteroid belt by ejection into Jupiter-crossing orbits or into collisions with growing terrestrial planets, i.e. by the same mechanisms responsible for the removal of asteroids and meteorites from the present asteroid belt. Acceleration of the residual asteroidal material to its present velocity distribution is a natural byproduct of the same gravitational processes. The final configurations of terrestrial planets are at least as satisfactory as those found when the initial distribution is much more narrowly confined.

In this scheme, the present asteroids would represent the residual fragmented collision debris from both embryos and from primordial planetesimals that did not accumulate into embryos. This speculation introduces a wide range of possibilities for the formation of metamorphosed, unmetamorphosed, and igneous asteroids and meteorites.

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