Asteroid structure and evolution project at UCSD

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In the vast reaches of interstellar space between Mars and Jupiter, countless thousands - perhaps millions - of bits and pieces of rock wheel about the sun in endless orbits.

These are the asteroids. The chill and forbidding wasteland in which they perform their mysterious gyrations is known to science as the asteroid belt.

Some known asteroids are jagged, mountain-sized chunks one or more miles in width. At least one is a small planet 500 miles across. Where did they come from? Are they, as some believe, the left-overs of primeval planets which collided and split asunder? Or which exploded, hurling their remains into space?

Early astronomers could detect neither rhyme nor reason in the distribution of these minor planets. Then, in 1917, a Japanese astronomer named Seiji Hirayama found what he believed was a pattern. He discovered that asteroids are grouped in "families," each "family" orbiting apart from others in the belt. Later studies confirmed the Japanese scientist's findings, and revealed the existence of at least 29 such clusters, each with from four to 62 members.

At first, Hirayama's discovery was interpreted as further support of the theory which holds that asteroids are products of exploded planets. More recently, however, serious doubts have been cast on the "explosion" and "collision" hypotheses. A newer view, the so-called "planetesimal" theory of the origin of planets, is that major planets in the Solar System were formed by the accretion, or coming together, of small grains of interplanetary matter. These grains were believed, in turn, to have come from clouds of gas.

If this is true, asteroids may represent an interim stage in the evolution of a major planet, a moment in the birth process when raw materials ran out and the coming-together ceased before a full-grown planet was formed.

And if this theory is true, the Moon, Earth itself, and other planets of the Solar System may have been born of the coming-together of cosmic oddments some four and a half billion years ago.

Scientists at the University of California, San Diego are seeking new knowledge about the structure and evolution of the asteroids. Aided by a $77,791 grant from the National Aeronautics and Space Administration, four international experts in widely different fields are involved in a special UCSD research project.

The project is headed by Dr. Hannes Alfven, a noted Swedish physicist on the UCSD faculty, and Dr. Henry G. Booker, chairman of UCSD's department of applied physics and information science. Collaborating with them are Dr. James Arnold, professor of chemistry and an expert on asteroids and meteorites, and Dr. Gustaf Arrhenius, professor of oceanography, who is also active in the field of cosmochemistry.

Alfven, who has contributed to space research for more than 30 years, hopes that the UCSD investigations will prove that asteroids are more than "mere bits of space rubbish." "It is obvious," said Alfven, "that breakup due to collision must also be a common process in the asteroid belt. But there are reasons to believe that the constructive coming-together on the whole outweighs the destructive fragmentation of the asteroids.

"If the asteroids are nothing more than debris," he continued, we naturally will find them of limited interest. But if they are, in fact continually crushed and recombined, and prove to be the building blocks which accumulate to create new planets, they are worthy of our most intense examination. Because from them we may discover much about the way in which our own Earth was formed, and about the evolution of the Solar System."

Alfven said he regards asteroids as even more promising sources of scientific information about the inner regions of the Solar System than the moon or other planets.

"We already have tangible samples of the Earth and Moon," he pointed out. "Meteorites also have been carefully investigated. Now it is important to study bodies which are intermediate in size between the Moon and the meteorites, and the asteroids arc such bodies. In this respect, a study of an asteroid is more important than the study of Mars or Venus."

At this moment in history, with interplanetary flights of manned spacecraft just around the corner, the UCSD project has also an immediate, and highly practical, significance.

"The study of the Flora 'family' of asteroids yielded surprising results," Alfven explained. 'It was found that certain groups in this family are moving in very similar orbits, thereby forming what we term 'Jet streams' of asteroids. Three of these jet streams have been identified, so far, in the Flora family. It is possible, therefore, that a large fraction of all asteroids move in such jet streams, so that the whole region between Mars and Jupiter is permeated by these streams.

"If just one of these bodies - even a very small one no bigger than a peanut - should smash into a spacecraft, it could spell disaster for the craft and its occupants.`

Space travel outside the orbits of these jet streams would be relatively safe, said Alfven. Therefore, if the UCSD studies indicate that jet streams pose a threat to space travellers, an attempt will be made to map their orbits "so that advisable routings for future space flights between Mars and Jupiter can be computed."

During some two centuries of astronomical observations, thousands of asteroids have been discovered. Accurate orbits have been computed for more than 1,700 of these, and new techniques will make possible the plotting of at least 50,000 more.

"Visible" asteroids observed and charted thus far by man make up only a very small fraction of all such bodies, Alfven noted.

"In fact, one may reasonably expect that there is a continuous distribution of these bodies, with diameters ranging from 100 kilometers - typical of the larger asteroids - down to a fraction of a centimeter."

The UCSD team will collaborate with astronomers in many parts of the world in developing new data on asteroid orbits.

In a recent article in Science, Alfven and Arrhenius proposed that serious consideration be given to a manned or instrumented flight to a suitable asteroid. Certain asteroids with regular intervals come close to the Earth. Eros, for example, will come within 14 million miles of the Earth in 1975. A trip to such a miniature planet might yield certain important clues to the origin and history of the Solar System, the two scientists said.