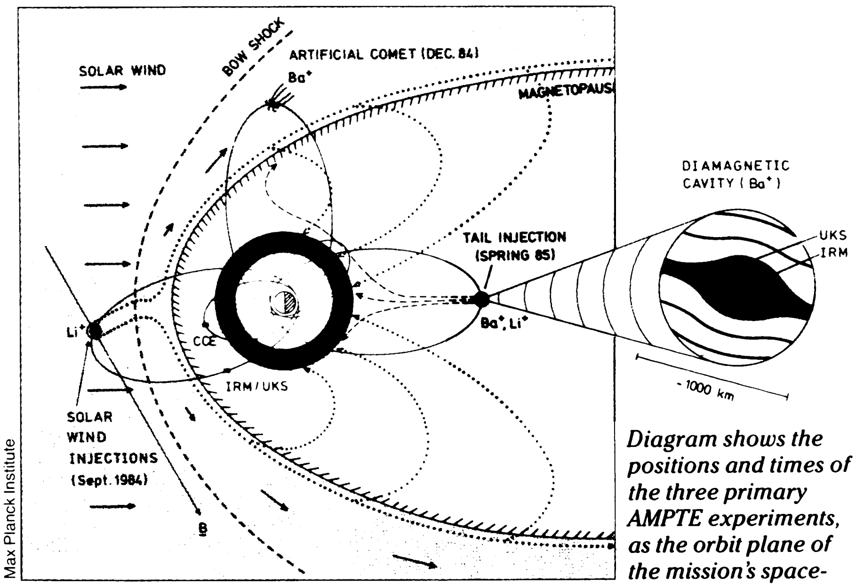
AMPTE Looks into the Invisible



Max Planck Institute

Diagram shows the positions and times of the three primary AMPTE experiments, as the orbit plane of the mission's spacecraft shifts relative to the sun. In September (left), lithium clouds will be released sunward of earth's magnetic "bow shock" as tracers to study the penetration of the incoming solar wind. Three months later (top), an "artificial comet" of barium ions will be produced over the dawn quadrant. And next spring (right and inset), additional lithium and barium clouds will be generated in the magnetic field's tail to see how ions introduced into the tail are transported toward the earth to form the Van Allen radiation belts.

It has long been known that the earth is a vast magnet, and the very first satellite ever successfully launched by the United States (Explorer 1 on Jan. 31, 1958) discovered that one of the geomagnetic field's major consequences is the presence of the "Van Allen belts" of trapped radiation that circle the planet. The "magnetosphere," as the field's domain is called, and the radiation belts have since been intensively studied, yet some of the most fundamental questions about both remain unanswered.

What portion of the particles that populate the belts is sent in from the sun by the solar wind (once thought to be the whole explanation) and what comes up from earth's own ionosphere? In fact, how much of the solar wind actually gets in at all, somehow penetrating the intense shock wave formed by the solar wind's supersonic collision with the magnetosphere? And what strange process is it that soups up the particles in the belts until they are from a thousand to a million times more energetic than they were when they left either source?

On the morning of Aug. 9, three satellites — one West German, one British and one from the United States — are scheduled to be launched from Cape Kennedy in Florida aboard a single Delta rocket. Deployed into separate, carefully calculated orbits so precise that their rocket will have to take off within a certain 10-minute "launch window" on any given day — part of the reason that they will not be riding the space shuttle — the probes will be addressing just such questions.

And the answers to all of them are invisible.

That problem is at the heart of the mission, known as AMPTE: the Active Magnetospheric Particle Tracer Explorers. To AMPTE's scientists, merely flying a load of instruments through the solar wind or the magnetosphere is not enough. How to tell, for example, whether a few million hydrogen ions (protons) came from the sun or the ionosphere? AMPTE's answer is to inject "tracers" of barium and lithium ions, easily distinguishable from solar and terrestrial outpourings, into the solar wind's flow and the lines of the geomagnetic field, like pouring visible dyes into the tributaries of a river to observe their mixing.

Such tracers have been used many times from sounding rockets and even on a few occasions from satellites to study earth's magnetic field, usually by visually tracking the glowing blue and purple clouds of ions as they reflect the sun. The satellite doing AMPTE's injections (the German Ion Release Module), however, will begin its work about a month after launch by deploying a lithium cloud in the solar wind before the solar wind ever reaches the shock wave, the first such experiment ever conducted outside the magnetosphere. Lithium ions are invisible (and would be unobservable in any event since the cloud would have to be viewed against the sun), but they will be tracked by instruments aboard both the German satellite and the nearby United Kingdom Subsatellite, which is equipped with its own propulsion system to vary the distance between the two probes. The U.S. satellite, meanwhile, called the Charge Composition Explorer, will be stationed *inside* the magnetosphere's boundary to see how much of the lithium, driven by the solar wind, actually gets through.

About six months later, the satellite's orbits will have shifted so that the probes will be able to repeat the experiment well down in the "tail" of the magnetosphere, on earth's night side. The tail is formed because the solar wind drags the magnetic field lines out beyond the planet, but evidence from other satellites has indicated that some particles from the tail are somehow directed "upstream" toward the earth. Here, AMPTE's clouds of barium and lithium (with a visible Europium tracer of its own) will be tracked both visually (with earth-based telescopes) and by the satellite's instruments.

AMPTE's most spectacular experiment, however, is planned for late December, when the Ion Release Module generates an "artificial comet" of barium to study the effects on a comet of the solar wind and magnetosphere. The powdered barium, deployed like the other tests from an exploding cannister, is expected to form a glowing cloud that will be visible from earth, where it will appear about one-third the size of the full moon. How fast will the solar wind sweep it away? AMPTE will take the first look. *—J. Eberhart*

NNTT: Multiple mirrors

Planners for a National New Technology Telescope have opted for a multiple mirror design, according to an announcement by the National Optical Astronomy Observatories, which had empanelled a committee to make the recommendation. The NNTT would be a national facility equivalent to a 15-meter diameter single mirror.

Telescope designers generally believe that monolithic single mirrors beyond the current world's largest, six meters, are impractical. Larger telescopes will have to be either multiple mirror designs, in which several mirrors all throw their images on one point, or segmented mirrors, in which each segment is independently supported and moved. A multiple mirror telescope now exists on Mt. Hopkins, between Tucson and Nogales, Ariz. A segmented one has never been built, but the University of California has chosen that design for its planned 10-meter instrument, so the future may see at least one large example of both. □