

are to improve this excitation method to make a greater quantity of the condensed phase so that parameters of interest to theorists can be more conveniently studied. And, he notes, if the droplet phenomenon is eventually of technological importance, electrical excitation will be advantageous.

—*Marian S. Rothenberg*

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Fifty-two nations join in Geodynamics Project

The birth of the plate tectonics model of the earth has provided impetus for the Geodynamics Project, an international program under the auspices of the International Council of Scientific Unions. Fifty-two nations are participating in the project, which is planned for the period 1971-79 with the first three years to serve as a planning period.

US participation in the program will be guided by the Geodynamics Committee of the NAS, which has prepared a report with the help of hundreds of scientists and scores of institutions. Federal funding of \$50 million to come primarily from NSF and the US Geological Survey will serve to promote five major objectives:

- ▶ to develop further the basic model of plate tectonics,
- ▶ to test and demonstrate its ability to

explain and predict phenomena,

▶ to determine the degree to which it can be extended, its limitations in scale, in time and in the phenomena it will explain,

▶ to investigate whether apparently unrelated geodynamic phenomena are independent or are in some way related to the model, and

▶ to examine the implications of the findings with regard to basic and applied research.

Geodynamics, the study of the forces and processes in the earth's interior, will be studied under the international program with particular attention paid to the basic mechanism of earth deformations. Information from the study should help to solve economic and societal problems relating to the solid earth by providing answers for issues of interest to federal agencies and mining and petroleum industries.

Cosmic gamma rays

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The stored recordings of data from gamma-ray sensors on board Vela, OGO and IMP satellites, and from x-ray telescopes on OSO-7, contain evidence of occasional bursts of photons in the energy range 150-250 keV, most of duration about ten seconds. The appearance of the events correlates neither in time nor position with any other known astrophysical phenomenon. Theoretical speculation runs through a gamut of models including shock waves in supernovae, stellar flares, collapsing neutron stars, comet capture by neutron stars, and many others. Interest in these bursts, as in the other transient astronomical observations, derives from the clues they could give to an understanding of the mechanism of the highest-energy processes in astrophysics—those associated with the final cataclysmic stages in stellar evolution.

Observations. About 20 gamma-ray bursts have now been identified in searches of records going back to 1967 data, giving an estimated rate of about four events per year over the whole sky. Coincidences among independent satellite observations serve to distinguish "good" data from noise and instrumental effects—only those events seen by two or more satellites simultaneously have been counted. This is all "archaeological" data, as Cline pointed out to *PHYSICS TODAY*. He believes that most of the old data are in now, and only occasional reports of new events are to be expected from currently orbiting satellite instrumentation.

The Vela series of satellites monitors the limited nuclear test-ban treaty of 1963; their sensitivity to short-term photon flashes in the gamma region

would, for example, detect bombs detonated behind the moon. Stirling Colgate (New Mexico Institute of Mining and Technology), a Los Alamos consultant, realized that this system would also be sensitive to gamma bursts that he and others believed would be released by supernovae. However, searches of early Vela data near the times of appearance of supernovae met with no success. Later Vela satellites, those numbered 5A, 5B, 6A and 6B, possess improved instrumentation, which allows short-time-scale phenomena to be more easily dug out of the old records, and much more accurate (± 0.016 sec) event timing. These four spacecraft (in orbit simultaneously) successfully detected 16 events in the period July 1969 to July 1972 that satisfied the criterion of simultaneous observation.

Vela detectors are omnidirectional, but comparison of the arrival times of a burst of photons at each satellite gives enough angular resolution to rule out the sun as the source of most of the observed bursts. There is no energy resolution in Vela data; the energy window for the detectors is 0.2-1.0 MeV (Vela 5) and 0.3-1.5 MeV (Vela 6).

News of these gamma-ray bursts set off a flurry of excitement in other groups holding similar data. At the NASA Goddard Space Flight Center, Cline and Desai were able to find one of the Vela events in their 1969 data from OGO-3 and had already independently extracted six more from the 1971-72 period in data from the IMP-6 satellite. These IMP-6 data provided direct evidence that the signals are produced by gamma rays and not charged particles or neutrons. Detectors on board OGO-3 and IMP-6 are omnidirectional, like the ones on the Vela satellites, but IMP-6 gives energy spectra not available from Vela.

The most complete observation available to date is of a burst that occurred 14 May 1972 (see figure). This one, as well as being observed by three Vela satellites and the IMP-6, fell within the scan path of the x-ray telescopes on board OSO-7. With these instruments (narrow-angle cosmic x-ray telescope and wide-angle solar x-ray telescope operated by the University of California, San Diego) unambiguous determination of the direction of the burst and time-dependent energy spectra were available for the first time.

Five of the events were seen by Uhuru, American Science and Engineering's x-ray satellite, and reported at the Los Alamos meeting by David Koch. Uhuru's collimators, effective in the 2-20 keV range, did not screen out the higher-energy gamma radiation, which produced Compton elec-