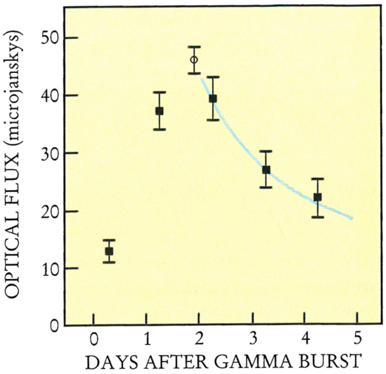

Light curve of the optical afterglow of the 8 May gamma-ray burster in the days following the burst. The solid squares are data from telescopes on Mount Palomar. The open circle indicates an observation at the 1.5-meter Loiano telescope in the Apennines. The drawn curve plots $1/t$ falloff, where t is the elapsed time since the gamma burst. (Adapted from ref. 2.)

Polar Orbiter Shows Evidence of Minicomet Bombardment

This multiple-exposure ultraviolet image, taken last September by the Visible Imaging System (VIS) aboard NASA's Polar orbiter, shows a 500-km-long trail of something roughly 10 000 km above the Atlantic, coming in toward Europe and shining brightly at 130.4 nm, a prominent UV emission line of atomic oxygen. The VIS has also recorded many such trails at 308.5 nm, a characteristic wavelength of hydroxyl-radical fluorescence.

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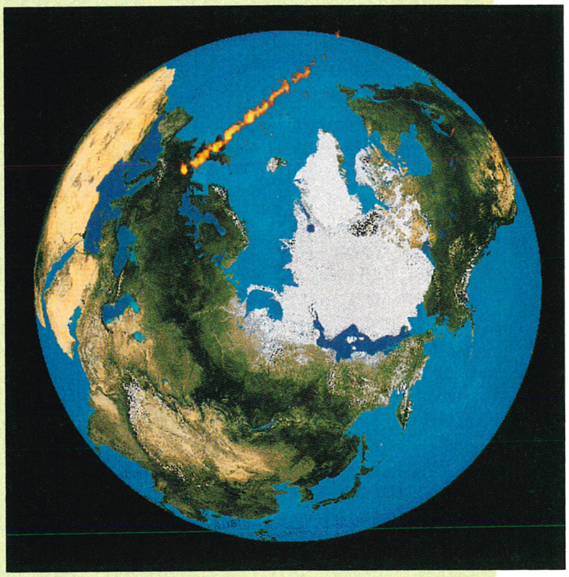

In three papers recently submitted to *Geophysical Research Letters*, VIS developer Louis Frank and coauthor John Sigwarth (both at the University of Iowa) argue that these infalling objects are kiloton minicomets, consisting mostly of water ice and bombarding the Earth at a rate of 10 or 20 a minute. An important part of their evidence is a steady patter of large, transient dark spots in the Earth's ultraviolet dayglow, recorded from above by the Polar orbiter. The UV trails, they conjecture, are generated by photodissociation of water molecules in sunlight as the minicomets begin to break up in the vicinity of the Earth; and the dark splotches indicate the final deposition of the water in the upper atmosphere.

The bombardment rate is highest in October and lowest in January. The authors argue for a large, persistent population of these water minicomets in a highly eccentric orbital band whose perihelion is near Earth's orbit. If this population of orbiting "snowballs" has really been pelting the Earth for billions of years, it could account for much of the water in our oceans—and who knows what else.

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first optical exposures were made at the 4.2-meter William Herschel Telescope 21 hours after the burst, but more than a week passed before the transient was identified and more powerful telecopes got into the act. By that time the optical image was too faint for adequate spectroscopy. But the observed optical and x-ray afterglows hinted at even greater rewards for rapid, concerted action next time.

Within 7 hours of the 8 May burst, BeppoSAX's wide field was under scrutiny by several optical telescopes and by the Very Large Array (VLA) of 27 radio dishes at Socorro, New Mexico. A day later, Howard Bond (Space Telescope Science Institute) announced that he had identified the optical transient with the Kitt Peak 0.9-meter telescope, and that this pointlike object was still getting brighter. Using two telescopes on Mount Palomar, Metzger's Caltech collaborator George Djorgovski and colleagues measured the light curve (see page **) of the optical transient's first five days.[2] The curve shows that the transient took about 48 hours to reach its peak brightness. That's a longer rise time than had been predicted by most theoretical models for GRBs at cosmological distances.

The VLA radio observations, led by Dale Frail of the National Radio Astronomy Observatory, saw nothing until 13 May, when they found a new 0.4-millijansky source at precisely the position of the optical transient. Two days later, it appeared to have begun fading, but then it leveled off and began to exhibit an erratic sequence of peaks. Frail and company are still trying to make sense of this peculiar behavior. Perhaps it's random scintillation due to multiple scattering off ionized gas in our Galaxy—the radio analog of star twinkling. In any case, the delayed onset of the radio transient relative to the optical transient is not a surprise. Most cosmological GRB scenarios do involve an early phase that is too dense for synchroton radiation at radio frequencies to escape.

"Able was I . . ."

At the end of May, observers and theorists gathered for a few days on the Mediterranean island of Elba, to digest the deluge of new data in recent months. "There were so many interesting theory talks," Metzger told us, "that we never got to see Bonaparte's exile villa." The theorists are now free to concentrate all their efforts on cosmological scenarios, that is to say, putative cataclysms capable of spewing forth something like 10^{52} ergs worth of gamma radiation in a fraction of a minute. Nothing much more modest than a black hole swallowing a neutron star in one gulp will do. Irrespective of the details of the initial event, the deposition of so much energy so fast into a small volume is expected to generate a fireball that expands at highly relativistic speed.

More optical and radio light curves will now be much in demand, to help choose from among the various speculations. Very-long-baseline radio interferometry is also getting into the fray. With antennae thousands of miles apart, it can achieve milliarcsecond resolution, which at $z \approx 1$ corresponds to only a few light-years.

As we go to press, we hear of two new developments: The good news is that an oxygen *emission* line, also at $z \approx 0.835$, has now been identified in the fading optical transient of the 8 May burster. The bad news is that another of BeppoSAX's guidance gyros has been misbehaving. That will limit the usefulness of the satellite for perhaps a month.

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References

1. M. Metzger *et al.*, Nature **387**, 26 June 1997.
2. M. Djorgovski *et al.*, Nature **387**, 26 June 1997.