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Models for Gamma-Ray Bursts

The discussion of one-step versus two-step models for gamma-ray bursts has been going on for much

longer than was indicated in the July 2002 issue of *PHYSICS TODAY* (page 18). Observations of delayed GeV gamma rays following GRB940217 led to the hypothesis that it was surrounded by gas from stripping of a progenitor star¹ (or one component of a progenitor binary). The inferred cloud dimensions and density are consistent with those estimated by James Reeves and colleagues² from the x-ray line emission they observed. It was also predicted that some or all gamma-ray bursts would be accompanied by visible emission resembling

that of a supernova as the gas is heated by collision with the relativistic debris that makes the burst itself. That prediction is now supported by evidence for supernova-like contributions to afterglows.³

References

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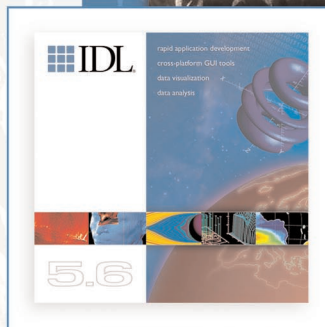
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Beautiful, Interesting Quaternions Are Valuable for Rigid Bodies

The picture-caption story in the October 2002 issue of *PHYSICS TODAY* (page 23) stated that Murray Gell-Mann would be delivering the Royal Irish Academy's inaugural Hamilton Lecture at Trinity College Dublin this year. Gell-Mann was quoted as saying, "They are celebrating Hamilton's quaternions, which are beautiful and mathematically interesting, even though they never proved to be of that much use for physics." Classical mechanics may be now relegated to applications, and may not be regarded as useful to physics. However, quaternions are useful in the treatment of the rigid-body problem. The formulation was achieved by the late Harold S. Morton Jr.¹

The state of the body is expressed in terms of the four Euler parameters and their four canonically conjugate momenta. The Euler parameters are the elements of a quaternion, subject to the constraint that the norm, the sum of the squares of the elements, is unity. That constraint is essential in the formulation.

Morton includes a numerical example for a torque-free rigid body. I wrote a Fortran code to implement these equations of motion for the case of a spinning undeployed spacecraft during the ascent phase of its motion, between separation from the launch vehicle and the application of a final maneuver that placed the spacecraft in a near-mission orbit. The results were in complete agreement with established alternative models.

The great advantage of Morton's