
“So, what if you found an asteroid that was predicted to hit the Earth? What could be done about it?” These questions are often asked of those of us who survey the sky for hazardous asteroids and comets. Two books have addressed the questions in detail at the scientific, peer-reviewed level. The comprehensive Hazards due to comets and asteroids, edited by Tom Gehrels, was compiled by 120 authors based on five meetings more than a decade ago. This new book is based on the Workshop on Scientific Requirements for Mitigation of Hazardous Comets and Asteroids, held in Arlington, Virginia in September 2002. Both books were sponsored by NASA and consist of many chapters by different experts spanning the wide range of disciplines relevant to this topic. Mitigation builds well on the ground laid by Hazards, taking into account what has been learned about asteroids in the intervening time and by developing new ideas and recommendations.

The answers to the original questions depend on how much warning time we would have before an impact, how massive the object would be, what its composition and mechanical structure is, what its orbit looks like, and what sort of technology is available to deflect the object’s trajectory. There are also social, political, and financial aspects controlling what can be done and how fast it be accomplished.

A now well-established concept addressed in detail here (and only mentioned as a possibility in Hazards) is that asteroids larger than about 200 meters in diameter are predominantly porous rubble piles that could absorb most of the energy from impacts or explosive devices without much effect on the motion of the center of mass. Small thrust applied for a long time has gained favor over single momentary impulses. The unlikelihood of an impact in the near future argues against building a complete deflection system to be kept on standby, but rather to learn how to deflect asteroids by studying their structure and doing experiments on them. Radar has advanced in its capabilities and findings, and more is now known about the population of potentially hazardous objects (PHOs) and their orbits. More comprehensive surveys are recommended to discover smaller-size objects, but it may be surprising to outsiders to learn how little is actually known about the masses of the asteroids being discovered. Harris of DLR argues for more ground-based telescopic measurements of physical properties such as albedo and size, yet we read the dismissive claim by Morrison et al. that we already know the impact frequency well enough. Indeed, much of the chapters on advice and recommendations do not address the contents of the technical chapters explicitly, making one wonder whether any discussion among the authors influenced their writing.

Three points of view on what size objects should be sought coexist in the book. First, the NASA-funded searches in progress are seeking the extremely rare, “large” civilization-destroyer that might happen, however improbably, to be coming within this century. That is the bare minimum of warning we might expect of our technological culture. Secondly, the workshop on which this book is based recommended that the search be extended to asteroids with
diameters down to 200 meters (http://www.beltonspace.com). That is consistent with the recommendations of the report of the Near-Earth Object Science Definition Team (Stokes et al. 2003; http://neo.jpl.nasa.gov/neo/neoreport030825.pdf). And finally, a thoughtful argument is made by Belton for how to find the types of PHOs most likely to impact within this century, that is, ones as small as 50 meters in diameter. The costs to achieve these three goals span the range from tens of millions to several billion dollars. Contrast this with Congress contemporaneously deliberating on annual awards of a few thousand dollars to amateur astronomers who contribute toward the discovery of near-Earth objects. But because impacts of even the most numerous small asteroids occur at an average interval of hundreds of years, it has been difficult to convince even our astronomical colleagues to award time on large telescopes to characterize PHOs, much less win additional funding from the government.

Some advice on communicating the hazard to the public is offered, but surprising inaccuracies in the chapter by Morrison et al. describing the rationales and actions surrounding the various “scare” in the popular media about possible impacts are so egregious that Brian Marsden, director of the International Astronomical Union’s Minor Planet Center, found it necessary to publish a rebuttal in another peer-reviewed venue, to appear soon. Fortunately, the relevant officials have more recently shown better attention to the collection of more observations rather than the checking of computations as the factor controlling what to say to the public and when.

The glossary definitions are not at the same technical level or quality as the contents of the book. The vague definitions of “dielectric constant” and “eccentricity” are condescending, and the Yarkovsky effect on the motion of asteroids does not require bodies to be irregular in shape. Peer review elevated the quality and readability of most of the articles above the expectations one normally has for a conference proceedings volume, although there is not complete uniformity in the quality and level of detail among the articles. I call them articles rather than chapters because the topics are diverse and there is no connecting synthesis. That is all right if we consider this as a source book that points to further literature. As such, the book is too specialized to be a textbook, but it might help a graduate student in planetary science, orbital dynamics, or space flight engineering to pick a dissertation topic. The appropriate audience also includes scientists and engineers who might be called upon to expand the search for PHOs, to characterize their physical properties, or to design a campaign of missions to experiment with deflecting the path of a non-hazardous asteroid. The book should also be on the shelves of officials of NASA and scientific staffers of interested members of Congress and the administration.

Robert S. McMillan
Spacewatch Project
University of Arizona
Lunar and Planetary Laboratory
Tucson, Arizona, 85712–0092
USA