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Foreword

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In 1992 a small workshop in San Juan Capistrano marked the beginning of an innovation in planetary exploration, the Principal Investigator-led mission. NASA announced the establishment of a continuing "line item" in the budget for the development, launch and operation of missions led by a Principal Investigator from inside or outside NASA. These missions were to be less costly than flagship missions that addressed the major objectives of planetary exploration. They would be more focused, developed more quickly for flight, with a limited number of instruments and a limited number of investigators. They would ensure that the smaller but important objectives of the planetary program would be addressed. The first two missions were selected in a mode similar to the earlier selection process to get the program off to a quick start but soon a new process was established. The best mission or pair of missions was to be selected from a group of about thirty proposals. From this process arose missions approved to go to the Moon, bring back solar wind and comet samples, to excavate a crater on a comet, to orbit Mercury, to orbit main belt asteroids, and to identify Earth-like exoplanets.

There is a rule of thumb in planetary exploration that every time you increase your resolution an order of magnitude, you make major discoveries. The increase in resolution is one of the reasons that missions to orbit planetary bodies are so important. You cannot obtain the needed resolution with telescopes at 1AU and a planetary flyby gives high resolution data only briefly and often on only one side of the body visited. One might not have thought that the Moon was ripe for such a revolutionary advance having been orbited closely in preparation for and during the Apollo program and visited multiple times in recent years but in one area it certainly was.

The GRACE mission in Earth orbit had shown the power of differential gravity measurements using a pair of spacecraft whose relative positions were accurately known. The

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team that successfully proposed the GRAIL mission knew that such measurements were also achievable on the Moon and could advance our understanding immeasurably at that body. This relatively brief two spacecraft mission has now been completed and the concept was a complete success. The Moon's gravitational field is now measured far more accurately and at higher resolution than ever before, and in fact better than the Earth. Although the data analysis is still in early stages the geophysics of the Moon is now far better understood and many paradigms have been turned on end.

Like the mission this special issue is short and to the point. It contains three papers from the mission team. The first paper by Maria Zuber and colleagues, provides an overview of the GRAIL mission; the science objectives, measurements, spacecraft, instruments and mission development, design, data flow and products. The second paper by S. Asmar and colleagues describes the scientific measurement system of the mission including the early modeling and simulation efforts. These enabled the scientific requirements to be converted to engineering specifications that became the primary drivers for development and testing. The third paper describes the implementation, testing and performance of the instrument complement flown on the two spacecraft.

The successful implementation of a mission as sophisticated as the Gravity Recovery and Interior Laboratory requires the hard work and assistance of many talented and dedicated individuals. In this instance these are not just the scientists involved, many of whom are the authors and coauthors of these articles, but also the engineers at the Jet Propulsion Laboratory and Lockheed-Martin Space Systems Company who designed, implemented, tested, and integrated the two spacecraft and their payloads, as well as the management at NASA and all who contributed to this mission. We are grateful to them all. The success of this volume is also due to many people. First of all the editors wish to thank the authors who distilled the voluminous material mission development produces, into highly readable articles. The editors also benefited from an excellent set of referees who acted as a test audience and helped refine the manuscript provided by the authors. These referees included Glenn Cunningham, Cheryl Gramling, Walter S. Kiefer, Ryan S. Park, Byron D. Tapley, Slava Turyshev.

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