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INTRODUCTION TO PAPERS ON ASTROSTATISTICS

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We are pleased to present a Special Section on Statistics and Astronomy in this issue of the *The Annals of Applied Statistics*. Astronomy is an observational rather than experimental science; as a result, astronomical data sets both small and large present particularly challenging problems to analysts who must make the best of whatever the sky offers their instruments. The resulting statistical problems have enormous diversity. In one problem, one may have to carefully quantify uncertainty in a hard-won, sparse data set; in another, the sheer volume of data may forbid a formally optimal analysis, requiring judicious balancing of model sophistication, approximations, and clever algorithms. Often the data bear a complex relationship to the underlying phenomenon producing them, much in the manner of inverse problems.

There is a long history of fruitful interaction between astronomy and statistics; indeed, problems in astronomy and geodesy motivated many developments marking the emergence of the discipline of statistics in the early nineteenth century. Interaction between these disciplines has waxed and waned in the subsequent two centuries. Happily, the turn of the twenty-first century marks an era of renewed enthusiasm for collaborations between astronomers and statisticians, giving rise to the interdisciplinary area of astrostatistics. Six papers in this issue describe compelling problems in astrostatistics.

The main driver for renewed interaction between statistics and astronomy has been the advent of large-scale astronomical surveys. Modern surveys probe scales of space and time ranging from our own solar system, to planets in other solar systems, to the structure of the Milky Way and distant galaxies, to the very early history of the universe, using instruments that are sensitive to regions of the electromagnetic spectrum ranging from radio (wavelengths as long as 100 km) to gamma-rays (wavelengths as short as 10^{-6} nanometers). Observations using non-electromagnetic "messengers," such as cosmic ray particles, neutrinos, and gravitational waves, are also playing increasingly important roles in modern astronomy. The papers in the Special Section all address problems arising in the context of surveys.

For decades, astronomers have known that the motions of stars and galaxies indicate the presence of significant amounts of gravitating matter that does not

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