10.1117/2.1200807.1195

Novel astronomical instrumentation for the Gemini telescopes

Joseph B. Jensen

Cutting-edge cameras and spectrometers will enable the Gemini Observatory to address fundamental questions about the nature of the universe and the origins of the stars and galaxies.

Instrument development plays a key role in the Gemini Observatory's mission to reveal the secrets of the cosmos.[1] Since astronomy is a technology-driven endeavor, the application of new technology in astronomical instrumentation invariably allows astrophysicists to address important questions, often with surprising results. To produce forefront science and compete in the global scientific arena, the Gemini Observatory must regularly update its instrument suite. The Near-Infrared Coronagraph (NICI)[2] is currently being commissioned on the Gemini-South telescope in Chile. NICI includes a sophisticated adaptive-optics (AO) system that provides the sharpest infrared (IR) images achievable. A specialized optical mask blocks most of the starlight, allowing us to see the faint reflections from Jupiter-mass planets orbiting young stars (see Figure 1). NICI observations will soon be scheduled to embark on a large survey aimed at discovering new extrasolar planets.

The FLAMINGOS-2 near-IR multi-object spectrograph[3] is nearing completion at the University of Florida. It is scheduled for delivery to the Gemini-South telescope by the end of 2008. With a large field of view for imaging and spectroscopic multiplexing capacity of up to 80 or more simultaneous spectra, FLAMINGOS-2 will be a powerful asset for the scientific community. The capabilities of FLAMINGOS-2 promise to help astronomers study the first galaxies in the universe and the formation of stars and planets in the Milky Way.

Gemini's Multi-Conjugate Adaptive Optics (MCAO)[4] system has been assembled in the lab and now awaits integration with the multiple laser-guide-star system on the Gemini-South telescope. This revolutionary AO system will provide sharper near-IR images than those produced by the Hubble Space Telescope, which operates outside the disturbing influence of the atmosphere, and over a much larger field of view. MCAO will be an excellent tool for exploring the properties of individual stars in the more crowded regions of the Milky Way and other nearby galaxies.

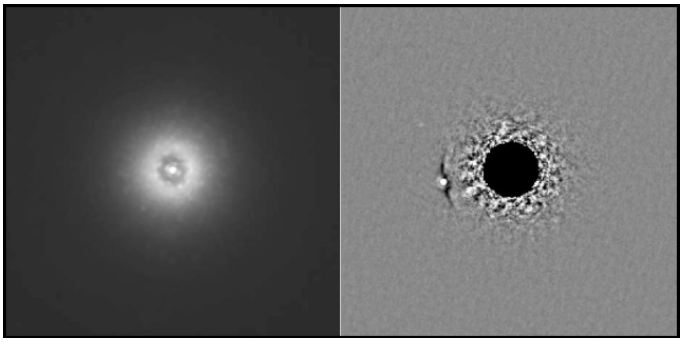

Figure 1. *Near-Infrared Coronagraph images of a nearby star. The left-hand image shows the star as seen through the semitransparent coronagraph mask. The right-hand image was processed to reveal a faint background star (at the eight o'clock position).*

The Gemini Observatory is now beginning to develop the next generation of instrumentation[1] to answer profound questions about the universe and our place in it. Many of these questions relate directly to the formation of planets, their physical characteristics, and how common they are. Others address the most fundamental questions about the nature of the baryonic and dark matter, and the mysterious dark energy that make up the universe.

The Gemini Planet Imager (GPI)[5] follows in NICI's footsteps. It has been designed to find and study planets orbiting other stars using a very high performance AO system and a sophisticated coronagraph to detect planets more than 10 million times

Continued on next page

fainter than their parent stars. GPI is now in the final design phase, and construction is scheduled to begin shortly.

The Wide-field Fiber Multi-Object Spectrometer (WFMOS) is a proposed instrument that would provide a groundbreaking capability to study the formation and evolution of the Milky Way and millions of other galaxies like it, reaching back to the earliest times of galaxy formation. WFMOS would permit ∼4500 spectra to be taken simultaneously across an ∼1.5° (diameter) field of view. This large multiplexing competence makes WFMOS a truly transformational instrument that will shed light on the mysterious dark energy thought to be responsible for the accelerating expansion of the universe. The observatory plans to build WFMOS in collaboration with our Japanese colleagues for use at the Subaru telescope in Hawaii. If built, the Japanese community will be partners in the construction and scientific mission of WFMOS.

The new instruments now being built for use with the Gemini telescopes will help astronomers around the world to answer fundamental questions about the nature of the universe, explore the origins of the stars and galaxies, and find many new extrasolar planets.

The Gemini Observatory is operated by the Association of Universities for Research in Astronomy Inc., under a cooperative agreement with the National Science Foundation (NSF) and on behalf of the Gemini partnership: the NSF (USA), the Science and Technology Facilities Council (UK), the National Research Council (Canada), CONICyT (Chile), the Australian Research Council (Australia), the Ministério da Ciência e Tecnologia (Brazil), and SECYT (Argentina).

Author Information

Joseph B. Jensen
Gemini Observatory
Hilo, HI

As head of instrumentation at the Gemini Observatory, Joseph Jensen is responsible for procuring new instruments for the two telescopes. He joined the observatory in 1997 after receiving his PhD from the University of Hawaii. His scientific interests focus on observational cosmology and measuring extragalactic distances.

References

1. D. A. Simons, J. B. Jensen, C. d'Orgeville, P. M. Gray, M. Lazo, R. Rogers, M. P. Sheehan, and J. K. White, *Past, present, and future instrumentation at the Gemini Observatory*, **Proc. SPIE 6269**, p. 4, 2006.
2. M. R. Chun, C. Ftaclas, D. W. Toomey, T. Hayward, F. J. Rigaut, Z. Wahhaj, B. A. Biller, M. C. Liu, L. M. Close, E. Artigau, and M. Hartung, *Performance of the near-infrared coronagraphic imager on Gemini South*, **Proc. SPIE 7015**, 2008. Paper 7015-66
3. S. S. Eikenberry *et al.*, *FLAMINGOS-2: the facility near-infrared wide-field imager and multi-object spectrograph for Gemini*, **Proc. SPIE 7014**, 2008. Paper 7014-29
4. M. Boccas *et al.*, *GEMS, GEmini Mcao System: current status and commissioning plan*, **Proc. SPIE 7015**, 2008. Paper 7015-32
5. B. A. Macintosh *et al.*, *The Gemini planet imager: from science to design to construction*, **Proc. SPIE 7015**, 2008. Paper 7015-43