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Author: Ms. Rati Srivastava
University of Petroleum and Energy Studies, India, ratisrivastava23@gmail.com

ADVANCED METHODOLOGIES FOR DESIGNING CRYOGENIC OPTICS FOR SPACE OBSERVATORIES: ACHIEVING OPTIMAL PERFORMANCE AND STABILITY AT LOW TEMPERATURES

Abstract

Cryogenic optics design is essential for maintaining optical precision and stability in low-temperature environments, such as space observatories. The design process involves several key steps, including identifying required optical performance, selecting appropriate cryogenic materials, optical design and simulation, structural design and simulation, integration, and testing. To ensure optimal performance, the desired optical bandwidth, resolution, and contrast ratio must be determined. Advanced materials, such as silicon carbide (SiC) and aluminum nitride (AlN), are commonly used due to their excellent thermal properties and stability at low temperatures. Optical design and simulation are performed using software tools like Zemax OpticStudio and COMSOL Multiphysics. These tools optimize the optical path length, correct aberrations, and minimize thermal effects, ensuring the desired optical performance and stability at low temperatures. Structural design and simulation are also crucial for maintaining stability and precision. Software tools like SolidWorks ensure the system can withstand harsh environmental conditions and thermal cycling during space missions. The final design is integrated into the observatory system and tested in a cryogenic environment for optimal performance and stability. In summary, the design of cryogenic optics requires advanced methodologies to ensure optimal performance and stability at low temperatures. The design process includes identifying required optical performance, selecting appropriate cryogenic materials, optical design and simulation, structural design and simulation, integration, and testing. Advanced software tools, such as Zemax OpticStudio, COMSOL Multiphysics, and SolidWorks, are essential for achieving the desired optical performance and maintaining stability at low temperatures.