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ZERODUR BASED OPTICAL SYSTEMS FOR QUANTUM GAS EXPERIMENTS IN SPACE

Abstract

Numerous quantum technologies make use of a microgravity environment e.g. in space. Operating in this extreme environment makes high demands on the experiment and especially the laser system regarding miniaturization and power consumption as well as mechanical and thermal stability. In our systems, optical modules consisting of Zerodur based optical benches with free-space optics are combined with fiber components. Suitability of the technology has been demonstrated in the successful sounding rocket missions FOKUS, KALEXUS and MAIUS-1.

Here, we report on our toolkit for stable optical benches including mounts, fixed and adjustable mirrors as well as polarization maintaining fiber collimators and couplers made from Zerodur [H. Duncker et al., Applied Optics 53, 4468-4474 (2014)]. As an example, we present the optical modules for the scientific rocket payload of MAIUS-2, a quantum gas experiment performing dual-species atom interferometry with Bose-Einstein condensates. The modules are used on the one hand to stabilize the laser frequencies and on the other hand to distribute, overlap and switch the laser beams. This includes the overlap and joint fiber coupling of beams at 767 nm and 780 nm in the same polarization state to cool and manipulate atoms of both species simultaneously.

Future projects include the development of a platform for experiments with cold atoms onboard the International Space Station. The laser system again involves Zerodur based optical benches in conjunction with fiber optical components. The experiment is planned as multi-user facility and currently in the design phase. The next step is to build the training, test and flight hardware.

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