Technology Advancement of the Visible Nulling Coronagraph

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ABSTRACT

The critical high contrast imaging technology for the Extrasolar Planetary Imaging Coronagraph (EPIC) mission concept is the visible nulling coronagraph (VNC). EPIC would be capable of imaging jovian planets, dust/debris disks, and potentially super-Earths and contribute to answering how bright the debris disks are for candidate stars. The contrast requirement for EPIC is 10^9 contrast at 125 milli-arseconds inner working angle. To advance the VNC technology NASA/ Goddard Space Flight Center, in collaboration with Lockheed-Martin, previously developed a vacuum VNC testbed, and achieved narrowband and broadband suppression of the core of the Airy disk. Recently our group was awarded a NASA Technology Development for Exoplanet Missions to achieve two milestones: (i) 10^8 contrast in narrowband light, and, (ii) 10^9 contrast in broader band light; one milestone per year, and both at 2 λ/D inner working angle. These will be achieved with our 2nd generation testbed known as the visible nulling testbed (VNT). It contains a MEMS based hex-packed segmented deformable mirror known as the multiple mirror array (MMA) and coherent fiber bundle, i.e. a spatial filter array (SFA). The MMA is in one interferometric arm and works to set the wavefront differences between the arms to zero. Each of the MMA segments is optically mapped to a single mode fiber of the SFA, and the SFA passively cleans the sub-aperture wavefront error leaving only piston, tip and tilt error to be controlled. The piston degree of freedom on each segment is used to correct the wavefront errors, while the tip/tilt is used to simultaneously correct the amplitude errors. Thus the VNT controls both amplitude and wavefront errors with a single MMA in closed-loop in a vacuum tank at ~20 Hz. Herein we will discuss our ongoing progress with the VNT.

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