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Title: PULSE: Palomar Ultraviolet Laser for the Study of Exoplanets
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Abstract: PULSE is a new concept to augment the currently operating 5.1-m Hale PALM-3000 exoplanet adaptive optics system with an ultraviolet Rayleigh laser and associated wavefront sensor. By using an ultraviolet laser to measure the high spatial and temporal order turbulence near the telescope aperture, where it dominates, one can extend the faintness limit of natural guide stars needed by PALM-3000. Initial simulations indicate that very-high infrared contrast ratios and good visible-light adaptive optics performance will be achieved by such an upgraded system on stars as faint as mV = 16-17 using an optimized low-order NGS sensor. This will enable direct imaging searches for, and subsequent characterization of, companions around cool, low-mass stars for the first time, as well as routine visible-light imaging twice as sharp as HST for fainter targets. PULSE will reuse the laser and wavefront sensor technology developed for the automated Robo-AO laser system currently operating at the Palomar 60-inch telescope, as well as take advantage of pending optimization of low-order NGS wavefront sensing and planned new interfaces to the PALM-3000 real-time reconstruction computer. A copy of the Robo-AO laser will be installed in the prime focus cage of the 5.1-m, and a new ultraviolet high-order wavefront sensor, fed by an ultraviolet dichroic, will be installed in the space above the PALM-3000 optical bench near the calibration sources. The laser measurements will drive the 3,388 active element high-order deformable mirror in open-loop, while an adaptive optics sharpened faint natural source will be measured by the current PALM-3000 wavefront sensor in its lowest spatial sampling mode, with commands sent in closed-loop to the 241 active element low-order deformable mirror. The natural guide star loop corrects for both the relatively weak low-order high-altitude turbulence as well as functioning as both the tip-tilt and low-bandwidth `truth' sensor loops in a traditional laser adaptive optics system.