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Developing and demonstrating linear dark field control for exo-Earth Imaging with the Ames Coronagraph Experiment Testbed

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toward lower-mass planets with currently available telescopes and those that will come online within the next decade.

342.04 — Identifying exoplanets with common spatial pattern filtering and a forward model matched filter

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Technology currently allows us to directly image some planets orbiting stars outside of our solar system. Doing so is understandably difficult - the light of an Earthlike planet is about a billion times less than that of the sun. Image post-processing techniques can be used in tandem with great technology onboard telescopes in order to help reveal planets in the presence of these noisy systems. This thesis work specifically shows that Common Spatial Pattern Forward Model Matched Filtering is an effective method for detection of point sources in specific examples of high-contrast astronomical images. A framework has been developed to allow analysis across many different true science datasets. This allows for systematic, large-scale statistical analyses of the CSP method applied to a variety of stars and injected data. We present results for multiple sets of observational data and show how CSP-FMMF compares to KLIP-FMMF (the current standard) in terms of SNR.

342.05 — Developing and Demonstrating Linear Dark Field Control for Exo-Earth Imaging with the Ames Coronagraph Experiment Testbed

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Imaging rocky planets in reflected light, a key focus of future NASA missions and ELTs, requires advanced wavefront control to maintain a deep, temporally correlated null of stellar halo at just several diffraction beam widths. We present the first laboratory tests of the Linear Dark Field Control (LDFC) method at contrasts and separations required to image exo-Earths around low-mass stars with future ground-based 30m class telescopes, using the Ames Coronagraph Experiment testbed. LDFC uses the response to perturbations in uncorrected, 'bright field' regions to maintain a dark hole without continuous DM probing. Our results show LDFC able to restore a dark hole whose contrast is degraded by up to a factor of 10 by perturbations and maintain this dark hole. We present preliminary results showing its efficacy under a range of DM perturbations, describe current limitations/challenges, and discuss future plans for testing LDFC at raw contrasts needed to image solar system-like planets (including Earths) around Sun-like stars.

Oral Session 343 — Exoplanets: Atmospheres III

343.01 — Machine Learning Retrieval of Jovian and Terrestrial Atmospheres

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Machine learning approaches to atmospheric retrieval offer results comparable to traditional numerical approaches in just seconds, compared to hundreds of compute hours. This opens the possibility for fully-3D retrievals to execute in times comparable to traditional approaches. Recently, we developed plan-net, an ensemble of Bayesian neural networks for atmospheric retrieval; we trained plan-net on synthetic Wide Field Camera 3 (WFC3) hot-Jupiter transmission spectra, applied it to the WFC3 spectrum of WASP-12b, and found results consistent with the literature. Here, we present updates to plan-net and expand its application to our 28-parameter data set of simulated LUVOIR spectra of terrestrial exoplanets generated using the NASA Planetary Spectrum Generator. By including both dense dropout and convolutional layers, we find a significant improvement in accuracy. MH and FS acknowledge the support of NVIDIA Corporation for the donation of the Titan Xp GPUs used for this research. AC is sponsored by the AIMS-CDT and EPSRC. AGB is funded by Lawrence Berkeley National Lab and EPSRC/MURI grant EP/N019474/1.