Introduction

Speckle imaging allows telescopes to achieve diffraction limited imaging performance. The technique requires cameras capable of reading out frames at a very fast rate, effectively ‘freezing out’ atmospheric seeing. The resulting speckles can be correlated and images reconstructed that are at the diffraction limit of the telescope. Three new instruments are based on the successful performance and design of the Differential Speckle Survey Instrument (DSSI) [2, 1].

The instruments are being built for the Gemini-N and WIYN telescopes and will be made available to the community via the peer review proposal process. We envision their primary use to be validation and characterization of exoplanet targets from the NASA K2 and TESS missions and RV discovered exoplanets. Such targets will provide excellent follow-up candidates for both the WIYN and Gemini telescopes [3]. Examples of DSSI data are shown in the figures below. We expect similar data quality in speckle imaging mode with the new instruments.

Additionally, both cameras will have a wide-field mode and standard SDSS filters. They will be highly versatile instruments and it is likely many other science programs will request time on the cameras. The limiting magnitude for speckle observations, will remain around 13-14th at WIYN and 16-17th at Gemini, while wide-field, normal CCD imaging operation and it is likely that many other science programs will request time on the cameras. The limiting magnitude for speckle observations, will remain around 13-14th at WIYN and 16-17th at Gemini, while wide-field, normal CCD imaging operation should be able to go to much fainter: providing useful CCD imaging and photometric capabilities. The instruments will also have high utility as scoring cameras for telescope engineering purposes, or other applications where high time resolution is needed. Instrument support will be provided, including a software pipeline that takes raw speckle data to fully reconstructed images.

WIYN

Telescope f/6.289
Plate scale 0.0374′′/mm

WIYNSPKL - Speckle mode

Focal Lengths
L1 30 mm
L2 200 mm
Detector Image Plane
Magnification 6-67x
Pixel Scale 0.00182 ″/pxl
Unvignetted Circle Dia 22 ″
Detector FoV 19 x 19 ″

WIYNSPKL - Wide-field mode

Focal Lengths
L1 100 mm
L2 150 mm
Detector Image Plane
Magnification 1.5x
Pixel Scale 0.00125 ″/pxl
Unvignetted Circle Dia 56 ″
Detector FoV 83 x 83 ″

Dichroic Edge 685 nm
This allows the blue (447nm) and green (562nm) filters in the reflective channel and the red (692nm) and infrared (880 nm) filters in the transmissive channel.

Filter Wheel A
central 1, bandwidth 60 µm
SDSS/g 406 nm, 140 nm
SDSS/i 625 nm, 140 nm
i-narrow 692 nm, 40 nm
t-narrow 562 nm, 40 nm

Detector QE/SDSS Filter Transmission

FWHM @ 500 nm 0.058 ″
FWHM @ 800 nm 0.064 ″

Discussion

Possible Exoplanet Applications

• Simultaneous two color transit photometry yields instant verification (same depth in both channels).
• Standard imaging provides host star photometry
• Speckle imaging assesses binarity and yielding correct exoplanet radius

Future Expansion

The filter wheels each have two remaining empty slots, we are currently exploring possible uses for these including the addition of:
• Transmission Grating - Grism
• Aperture Mask

Possible science application include: exoplanet transit spectroscopy, exoplanet atmosphere detection, transit object classification and characterization.

An aperture mask would allow spatial resolution beyond the diffraction limit. Achieving true interferometric resolution (2.4/k the diffraction limit). This could be especially interesting if used on next-generation ELTs.