ROLE OF DIFFRACION LIMITED PHOTONIC SPECTROGRAPHS IN EXOPLANETOLOGY: CASE STUDY OF HPCF COUPLED ECHELLE SPECTROGRAPH – MODAL STABILITY, SPECTRAL SENSITIVITY AND NOISE FLOOR FOR DETECION OF SUPER EARTHS

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In this poster I will demonstrate the potential of using photonic technologies in the field of exoplanetology. Case study that will be presented is a compact echelle spectrograph that is coupled with the telescope via the Hollow Core Photonic Fibre. Rigorous numerical simulation of mode coupling and propagation will be demonstrated. The fiber in this study is the endlessly single mode HPC fiber whose properties will be discused. The greatest hinderance to stability of clasicall echelle spectrographs is the PSF nonuniformity and the multitude of modes that propagate through the multimode fiber that transforms to inaccuracies in wavelenght on CCD. A number of devices have been implemented to mitigate this noise contribution: from fiber shakers to modal scramblers but none of them is as suitable for high stability and precision RV studies as are single mode fibers. Standard single mode fibers have Gaussian beam profile and are restricted in diameter to 7 micrometers and in spectral bandwith to a interval of 200 nm. HPC fibers mitigate those two shortcomings of classical single mode fibers by carefuly sculpting arrayed waveguide structure through which only single mode propagates but which is not limited in terms of diameter, polarisation state or spectral bandwith. The use of one such HPC fiber coupled to crosdispersed echelle spectrograph will be presented in order to qunatifiy the gains in resolution, SNR and spectral sensitivity.

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APPLICATIONS OF PHOTONICS IN EXOPLANETOLOGY: DIFFRACTION LIMITED SINGLE MODE ECHELLE SPECTROGRAPHS AND ATOMIC LINE REFERENCED FIBER FABRI PEROT CALIBRATORS FOR REACHING EXTREME PRECISION RADIAL VELOCITIES IN DOPLER SPECTROSCOPY

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In this work we will discuss aplications of photonic technologies in the field of exoplanetology. In order to fulfill a task of detection of earth mass planet around a solar analagous star a suite of stirgient requirements have to be met. First is stabilisation of the instrument be it mechanical stability, pupil illumination and PSF profile, temperature or pressure. Second is precise and absolute referenced callibation sistem with equidistant and uniform spectral features. First criterion is met by use of single mode optical fibers that couple spectrograph to the telescope. SMFs conduct only fundamental mode that result in a Gaussian beam profile through which modal noise is mitigated. Due to of small size of the pseudoslit presented by the fiber exit resolution is larger, spectrograph optics can be made order of magnitude smaller, less dependent on aberration control an due to reduced volume such instrumetns are easy to temperature and pressure stabilise. Second criterion is met by use of Fiber Fabry Perot Interferometers that are absolutely referenced to the D_2 line transition of Rubidium atoms by use of Saturation Absorption Spectroscopy. The FFPI are compact photonic devices that deliver a set of equidistant and homogeneous spectral features. By use of cross-correlation, absolute locking to Rubidium lines, and periodic referencing to Th-Ar lines we can achieve stability of less than m/s during the weeks of continuous use.

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