Wave Optic Analysis of Fizeau Fringes with Plate Defects.
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ABSTRACT

Analysis of fringes in Fizeau wedge interferometers has long been carried out by techniques of ray optics, and calculation of fringes of equal thickness. In most cases of small plate separation, large wedge angle and relatively smooth plates such treatment is perfectly satisfactory. However for larger plate separation, small wedge angle and semi-regular micro defects a more rigorous analysis of wave propagation between the plates becomes essential.

We have recently investigated a Fizeau system with plates of ~70mm separation and ~ 5μrad wedge. The surfaces, polished by Magneto Rheological Finishing (MRF), had an underlying spiral groove structure of ~ 1mm pitch and up to ~ 3nm depth – well within the λ/100 specification. However the experimental Fizeau fringes showed a broken/modulated appearance that could not be explained by simple ray optics. We have carried out a full, rigorous wave optic analysis based on a numerical solution of the paraxial wave equation, with a computationally efficient algorithm employing fast Fourier transforms. The results closely matched the experimental observations. An extensive investigation of the spectral response of the interferometer and anomalies resulting from the cyclic plate defects revealed remarkable differences compared with the ray optic treatment. Practical guidelines will be discussed and comparisons made with operation of the Fabry Perot interferometer.