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Master thesis and internship[BR]- Master's thesis : Development of an advanced modelling tool for a four apertures nulling interferometer[BR]- Integration internship

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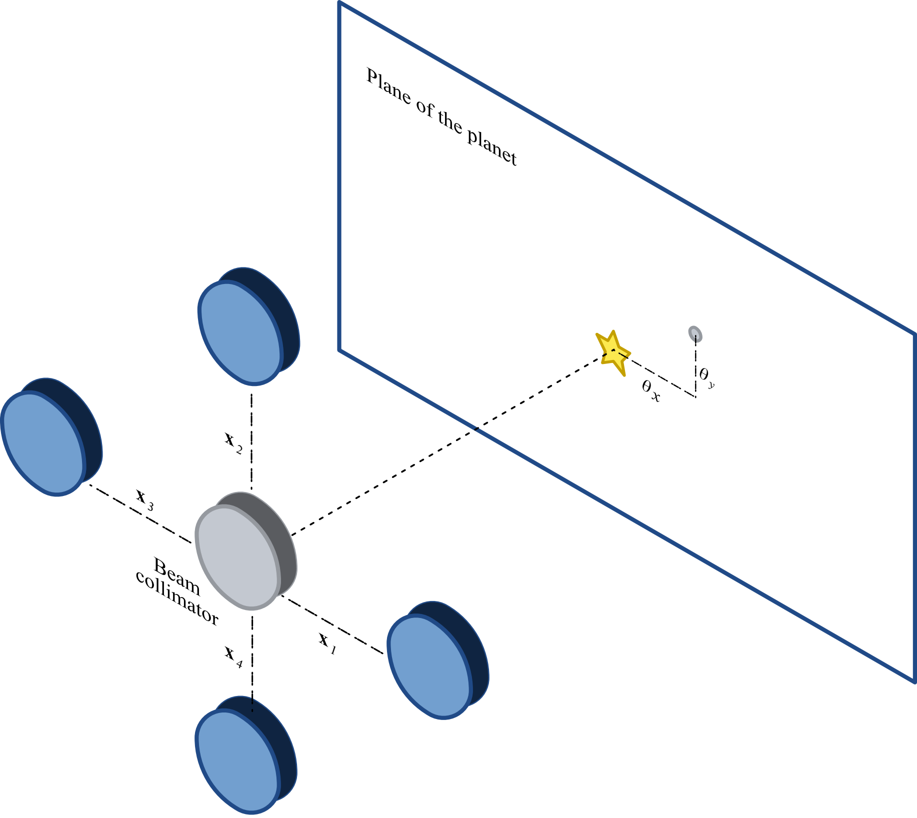
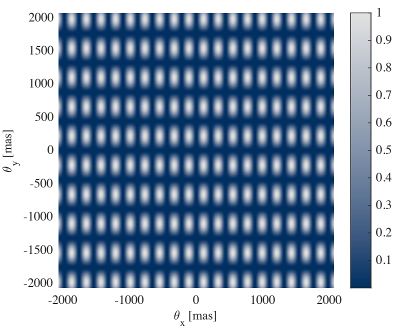
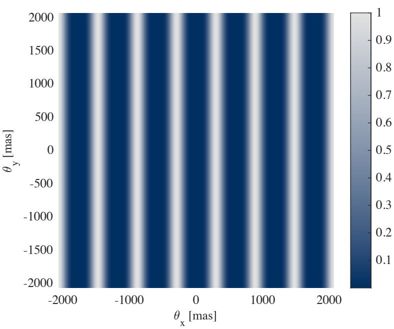


(a) Simplified schematic representation of the problem.

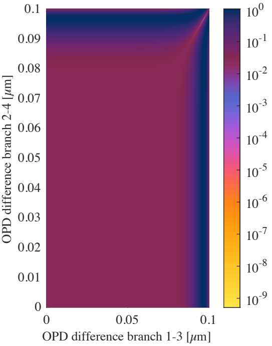


(b) X array

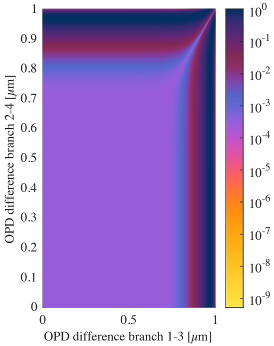


(c) Linear array

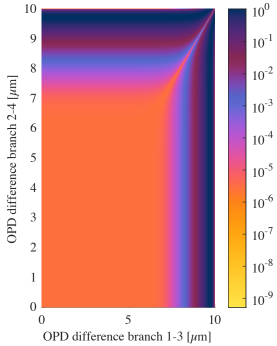
Figure 1: Diagram of the considered system: taking as reference the direction of the combiner and the star, assuming the interferometer to be in a plane configuration, normal to this direction, it is possible to identify the positions of the different apertures with bidimensional vectors $\mathbf{x}_i$, as well as every position on the image plane (which is a projection of the three-dimensional space) with the angular positions $\boldsymbol{\vartheta}$. The geometric shape of the array, as well as the assigned phases, lead to different transmission maps (interferometry construction or nulling), like in the cases of the Linear and X-Array configurations.



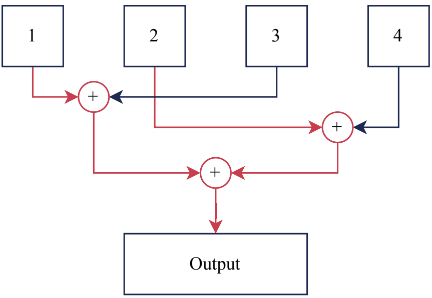
(a) $\lambda = 0.1\,\mu\mathrm{m}$



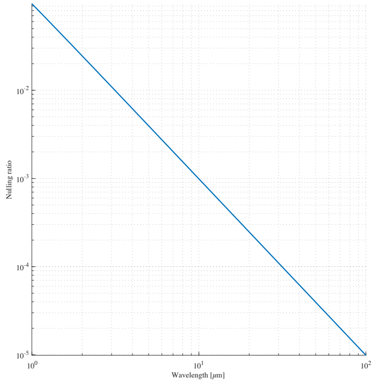
(b) $\lambda = 1\,\mu\mathrm{m}$



(c) $\lambda = 10\,\mu\mathrm{m}$



(d) Imposed perturbation.



(e) Single point variation

Figure 2: Achievable nulling ratios for imposed OPDs along the two Bracewell's branches for three different wavelengths. The three figures share the same colour-map for references, but the axes have different limits to avoid incurring in the periodic repetition. The schematic representation shows the considered cases within a DCB setup following the presented analysis for the X-Array. The red lines represent the perturbed elements in the analysis. For a single point, visualisation of the variation of the achievable nulling ratio for a specific OPD point ($0.2\,\mu\mathrm{m}$ along branches 1-3 and $0.1\,\mu\mathrm{m}$ along branches 2-4) for different wavelengths.

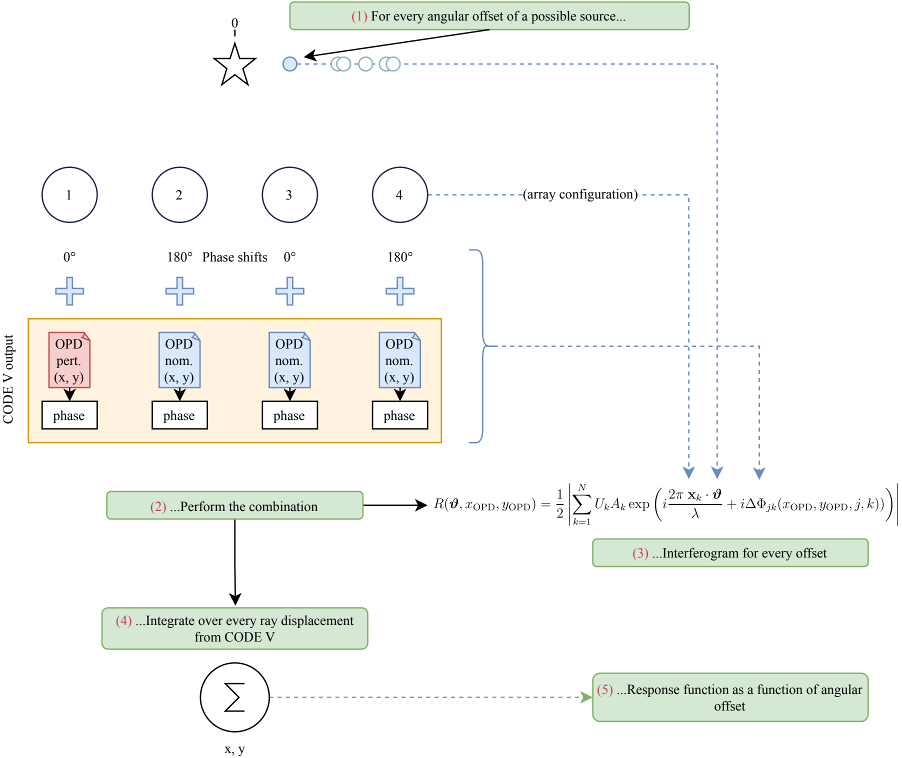
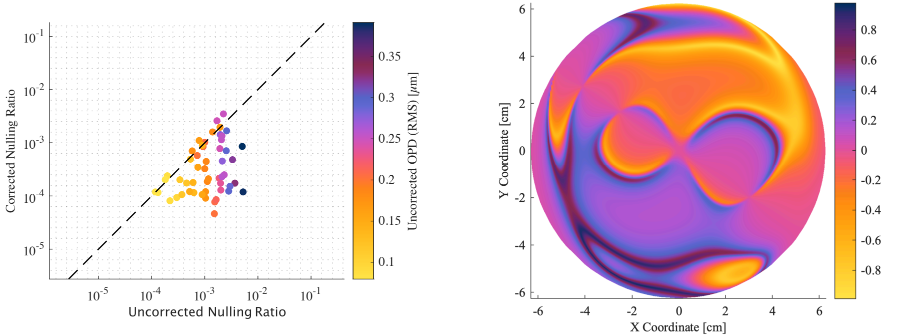


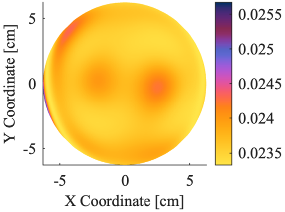
Figure 3: Block diagram of the algorithm used to compute the interferogram response and its integration: the response function is not computed anymore as a function of the angular position on the image screen $\boldsymbol{\vartheta}$ but as a function of the x, y coordinates on the pupil screen.



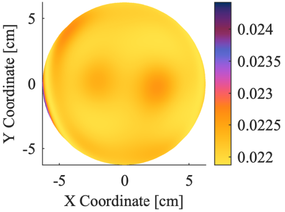
(a) Correlation of the correction

(b) Improvement scale

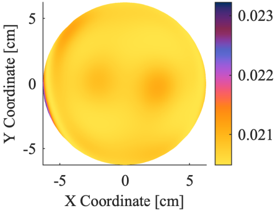
Figure 4: Improvements brought by the bisection compensator on the analysis. On the left: the resulting global nulling ratio for each simulation is plotted for the two cases. Each point that lies below the bisection line is an improvement over the unperturbed result. On the right: index of improvement of each point at the pupil screen, negative points are improved, while positive points got worse.



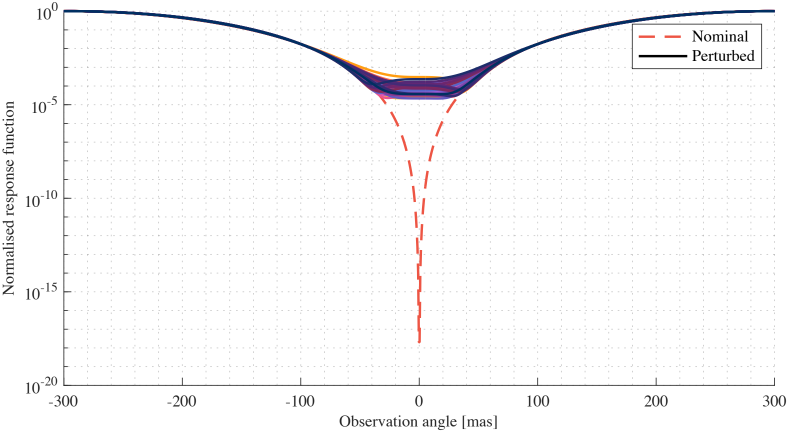
(a) -300 mas



(b) 0 mas

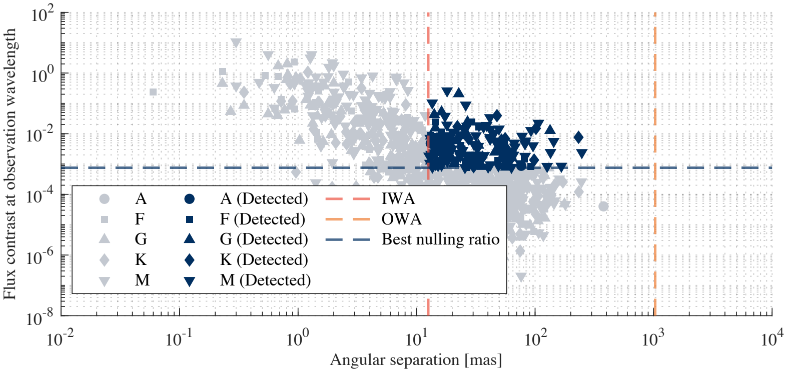


(c) 300 mas

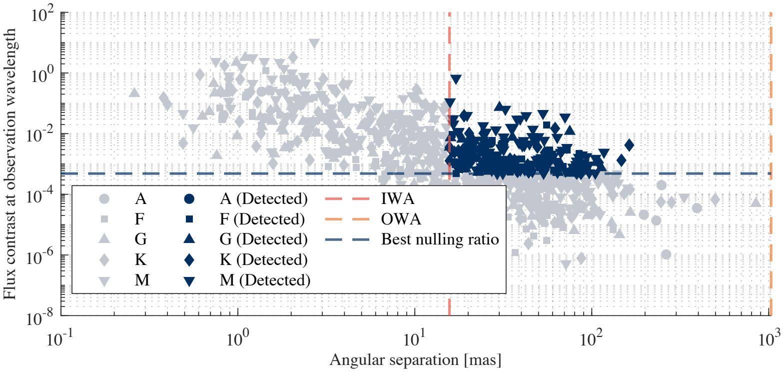


(d) Integrated response function

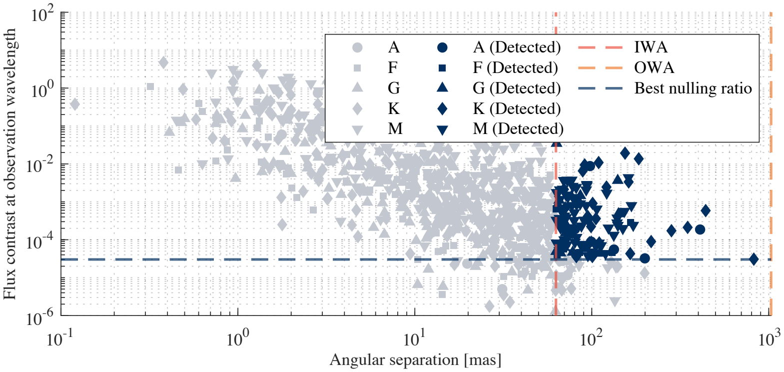
Figure 5: Above: intensity response (in m^4) for every displaced ray of a Linear Array interferometer at pupil plane for different angular positions (where 0 mas represents the target point, i.e. the target star) on the screen. All these angular positions belong to the same simulation. Below: comparison of the normalised integrated response function for the nominal and the perturbed system.



(a) Darwin.



(b) TPF-I.



(c) LIFE.

Figure 6: Comparison, for three different universes, of the possible resulting yield of the three missions.