Real-time computing methods for astronomical adaptive optics

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Astronomical imaging with ground-based telescopes suffers from quickly varying optical distortions, which cause blurring and loss of contrast. Since the image quality is essential for astronomical observations, a method that compensates these aberrations is required. This technique is called Adaptive Optics (AO). AO systems that achieve a good correction over a large field involve a tomographic estimation of the atmospheric wavefront disturbance. Mathematically, the atmospheric tomography problem is severely ill-posed. Moreover, the reconstruction has to be performed in real-time. In this talk, we present the augmented Finite Element Wavelet Hybrid Algorithm, which is a wavelet based method that allows a matrix-free representation of all operators involved. This approach considerably reduces the computational load and memory. The method is highly parallelizable and utilizes an augmented Krylov subspace method in order to reduce the number of CG iterations. We analyze the performance of the algorithm on a multi-core CPU and a GPU.