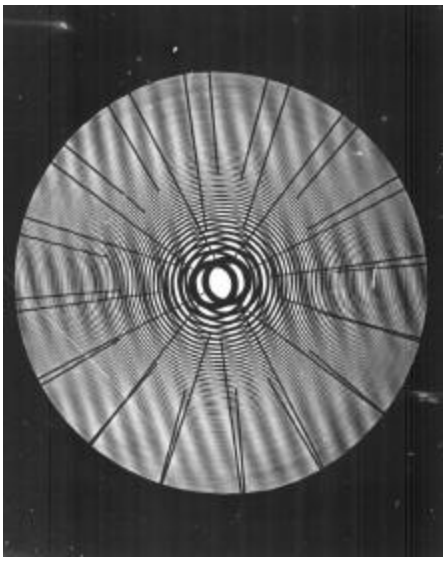
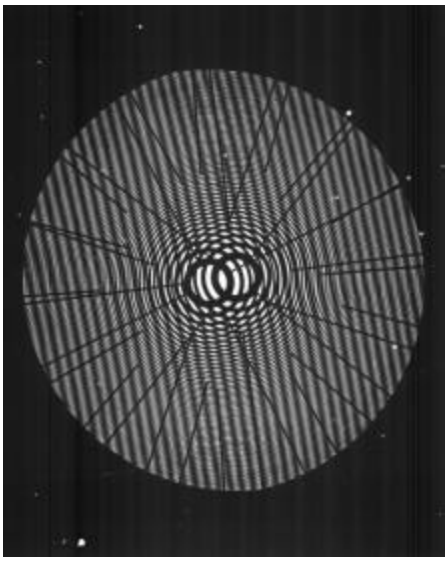
High Spatial and Temporal Imaging of Solar Flares over a Wide Band of Energies



Fringe Pattern due to Source ~ 0.15° Off Axis



Fringe Pattern due to Source ~ 0.3 Off Axis

1. Fundamental Question: Understanding the energetics and dynamics of solar flares.

2. Pursuit of transient rather than steady state behavior of sun

3. Imaging of solar flares over a wide band of energies by simultaneously acquiring both high temporal and spatial resolution images .

4. Unique feature of this concept is biplane coder, which provides high angular as well high temporal resolution using even a very coarse image plane detector

5. Two Fresnel Zone plates (FZPs) are used to acquire images. This imager acts like a direct Fourier transformer. The Moire pattern generated by this imager enables use of very coarse detector. Since no rotation is required in this scheme, one can achieve high temporal imaging of flare activity. Angular resolution of the order of arc second or better and temporal resolution of the order of a few milliseconds can be achieved by proper design of the telescope. Since we use high Z material like tungston, we can image from sub KeV to hundreds of KeV.

6. The technology requirement in the fabrication of the zone plates has been already demonstrated. FZP with finest zone of 40 microns made out of one millimeter thick tungston have already been made. The technology is cheap and scalable both in size and thickness .

High energy photons can not be reflected or refracted efficiently. Shadow casting due to total absorption – coded aperture imaging offers hard x-ray and gamma ray imaging capabilities. Most of the coders used are single plane coders. The angular resolution achieved in such single plane coders depends upon the finest feature of the coder as well as the distance between the coder and the image plane detectors. The finest feature of the coder has to be resolved by the detector to achieve high angular resolution. Non-availability of large area, high position sensitive detectors has constrained high angular resolution measurements. Rotating modulation collimator (RMC) uses sets of rotating grids to modulate the signal temporally. This concept does not require any position sensitive detector. A set of grids provides a special frequency of the object. Therefore, one has to have a multiple sets of grids to provide the total image of the object. The other bi-plane coder concept, which we have demonstrated uses two zone plates. In this scheme, the top FZP casts a shadow on the bottom FZP. And at the detector plane, one gets a Moire pattern. The frequency of the Moire fringes and their orientiation define the direction of the arrival of the beam with respect to the axis of the telescope. Essentially, this coder acts as a Fourier transformer and provides the Fourier transformation of the object. In this scheme, no rotation is needed and one can achieve high time resolution imaging capability only depending on the flux.

This concept also provides zooming capability to enhance angular resolution. Because of the centro-symmetric nature of the coder, zooming can be easily achieved by changing the distance between two FZPs. One can also use off-axis zone plate to achieve much wider field of view providing high angular resolution capability.