50.10 Planned Improvements to the Owens Valley Frequency-agile Interferometer for MAX '91
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The Owens Valley frequency-agile interferometer is designed to obtain high spatial and high spectral resolution observations of solar active regions and flares. The principle scientific motivations for doing so are based on the facts that (i) for active regions the microwave spectrum provides the only observational basis for measuring the strength of magnetic fields in the lower corona, and (ii) from flare brightness temperature spectra we can readily distinguish between thermal and nonthermal sources and can determine source parameters such as temperature, electron density, magnetic field and/or electron spectra.

In its present form, the Owens Valley interferometer is based on a pair of solar-dedicated 27 m diameter parabolic antennas, with another, 40 m antenna occasionally providing a third element. The antennas are equipped with frequency-agile receivers which can be tuned in rapid succession to as many as 86 frequencies between 1 and 18 GHz. The principle current limitation is that the small number of baselines (1 or 3) severely restricts the complexity of solar sources to which microwave spectral diagnostics can be applied.

The primary feature of the planned upgrade is to supplement the pair of 27 m antennas with a number of small, 2 m diameter antennas equipped with frequency-agile receivers. Additional correlators and related hardware, usually an expensive item in multi-antenna arrays, will not be required since the present system can be rapidly time-multiplexed to sequentially correlate different antenna combinations. The ability to apply the diagnostic power of spatially-resolved microwave spectroscopy will provide a significant new dimension to the study of solar flares and active regions over that available during the present solar maximum.

50.11 Millimeter Wavelength Observations of Solar Flares for MAX '91

The present Hat Creek 3-element millimeter interferometer is being expanded into a 6-element array, to be operated by the Berkeley-Illinois-Maryland Millimeter Array (BIMA) consortium. This array will have sub-arc second spatial resolution and fraction of a second temporal resolution. One important problem that can be studied from quasi-dedicated observations with such an array is that of gamma ray-mm wave flares. In such flares recent evidence has demonstrated that electrons and protons are accelerated almost simultaneously to very high energies and emit both mm waves and continuum gamma rays of high intensity. This continuum radiation is accompanied by nuclear gamma ray lines at energies less than ~ 10 MeV due to protons, and neutrinos are sometimes detected at Earth. There is no widely accepted explanation for this very rapid acceleration. Some argue that there must be a "first phase" process because of the very short time scale, possibly involving electric fields in double layers. Others argue that shock acceleration can act on short enough time scales. Since there have been no spatially resolved studies, other mm wave array can play an important role for understanding these very energetic solar flares. Also, important clues can be obtained for understanding the cause of brightenings that occur in Hα, EUV and even white light simultaneously with hard X-ray bursts. In addition to the imaging observations as mentioned above, we are exploring the possibility of using one antenna to monitor the total sun at several wavelengths within the millimeter array.

51.01 The Need for Hard X-Ray Imaging Observations at the next Solar Maximum
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Existing observations of the hard X-ray spatial structure during the impulsive phase of solar flares have been primarily at relatively low energies, and with relatively poor time resolution and count statistics. However, these results have tantalized us with the possibility that, with modest increases in time resolution and detector sensitivity, we will be able to trace the acceleration and propagation of bremsstrahlung-producing electrons through hard X-ray imaging observations. These electrons may contain the bulk of the energy liberated during the primary energy release process.

We will report on recent modeling results, showing the predicted evolution of the hard X-ray spatial structure with time during the impulsive phase of a flare. These results include self-consistently the hydrodynamic evolution of the bremsstrahlung target in response to the electron heating. We will also show how arc-second images of a flare at one-second intervals may be able to probe the fundamental physics governing the dynamics of suprathermal electron beams in plasmas. Tests of the predictions from both these modeling studies are possible with instrumentation currently under development for the MAX '91 program.

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51.02 The Imaging X-Ray Spectrometer (IXRS) for the Argentinian Satellite de Aplicaciones Cientificas - 1 (SAC - 1)

The Imaging X-Ray Spectrometer (IXRS) is one of four instruments on SAC-1, the Argentinian satellite being proposed for launch by NASA on a Scout rocket in 1992/3. IXRS is designed to provide solar flare images at X-ray energies between 0.5 and 35 keV. Observations will be made on arcsecond size scales and subsecond time scales of the processes that modify the electron spectrum and the thermal distribution in the flaring magnetic structures. The results will address the following scientific questions:

- Where are the sites of particle acceleration and interactions and how do they evolve spatially and spectrally during flares?
- What role do energetic electrons play, particularly those with energies below 50 keV, where the bulk of the total energy in electrons must reside?
- Where are the sites of plasma heating and how does the thermal energy propagate during flares?
- What is the relationship between the thermal flare plasma and the energetic particle and what role does the "superhot" plasma (>2x10^6 K) play?

IXRS will be capable of imaging X-ray sources on scales as small as 2-3 arcseconds and as large as 3 arcminutes. It will have a sensitivity two orders of magnitude greater than that of the Hard X-ray Imaging Spectrometer (HXIS) on SMM. These advanced capabilities are made possible on such a small spin-stabilized spacecraft by using a Fourier-transform imaging technique. Six rotating modulation collimators (RMCs), each with its own x/y proportional counter, are used to measure over 160 spatial Fourier components of the X-ray image. The amplitudes and phases of the Fourier components are determined in real time on board the spacecraft so that ~1000 images per flare can be telemetered. Reconstructed X-ray images can be obtained during a flare in up to 16 energy channels every 2 s for larger flares, less complete images will be produced on subsecond time scales. This technique of measuring the spatial Fourier components of a source and reconstructing the X-ray image on the ground is mathematically analogous to the imaging technique used in multi-baseline radio interferometry, e.g., at the VLA.

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