Evidence for magnetic loop asymmetry from HXR footpoint areas
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SUMMARY
- Flare footpoint asymmetries are common
- Are seen by RHESSI both in size (new) and flux
- Previously HXR1 and radio1 showed only flux asymmetries
- This usual interpretation is in terms of magnetic asymmetry
- Convergent magnetic fields
  - Elastic trapping
  - Localize the precipitation of electrons

EXAMPLES OF DOUBLE-SOURCE FLARES MAPPED FROM VISIBILITIES

THE SAME FLARES MAPPED WITH RHESSI CLEAN

INTERPRETATION:
MAGNETIC ASYMMETRY AND MIRRORS
In asymmetric loops, the footpoint is larger where the mirror point is lower, where precipitation is enhanced, hence X-ray flux should correlate with area or width (Melrose and White, 1979).

HOW THE NEW METHOD WORKS
RHESSI is a modulation collimator, i.e., a Fourier imager. Its modulation profiles yield flare visibilities. Image model using 8-12 parameters. Compute visibilities from the model (i.e., Fourier transform). Vary the parameters until model and flare visibilities agree. The next figure shows some observed amplitudes for RHESSI visibilities.

EXAMPLE OF AMPLITUDE PROFILE
A Double-component RHESSI flare
- Bumps and wiggles are caused by the sources "beating" against each other.
- Curve was fit by a set of 8 parameters describing two circular Gaussians.

VALIDATION OF FIT:
Agreement with bumps/wiggles
Cross sections thru χ2 space
Residual max as fraction of bmap max
Sensitivity to increasing # of parameters
Similarity to imaging by other means

SOME OBSERVED WIDTHS AND FLUXES
- A sample of 26 double-component events
- FWHM plotted against flux
- The brighter component is also wider (as predicted by Melrose & White, 1979)
- The slope of the lines between faint & bright components is almost always positive.
- Error bars measure confidence in result

COMPARISON OF RHESSI OBSERVATIONS OF AREA AND FLUX ASYMMETRY WITH MODELS

APPLICATION OF OUR NEW RESULTS TO THE PHYSICS OF FOOTPOINT ASYMMETRY
- e-electron’s mirror invariants hold
- Footpoint fill factors = 1
- Two extremes for pitch angle scattering:
  - TEE-scattering >> [mirroring] (Aschenbach et al)
  - TEE-scattering << [mirroring] (new)
- Compare asymmetries with predictions

MODEL 1: NO PITCH ANGLE SCATTERING

MODEL 2: RAPID PITCH ANGLE SCATTERING

CONCLUSIONS
- Observed footpoint area and flux asymmetries disagree with a model without pitch angle scattering. A model with pitch angle scattering is consistent with the observations. This suggests that pitch angle diffusion is important in flare loops.
- Systematics in the determination of areas must be carefully considered.
- Comparisons with magnetograms can check the sign of the width asymmetry.
- Microwave observations can aid in estimating the degree of trapping, to check the consistency of our results.