Spectroscopy of e^+–e^- Annihilation

Positrons can annihilate in flight and after formation of positronium.

Positronium breaks down at high temperature.

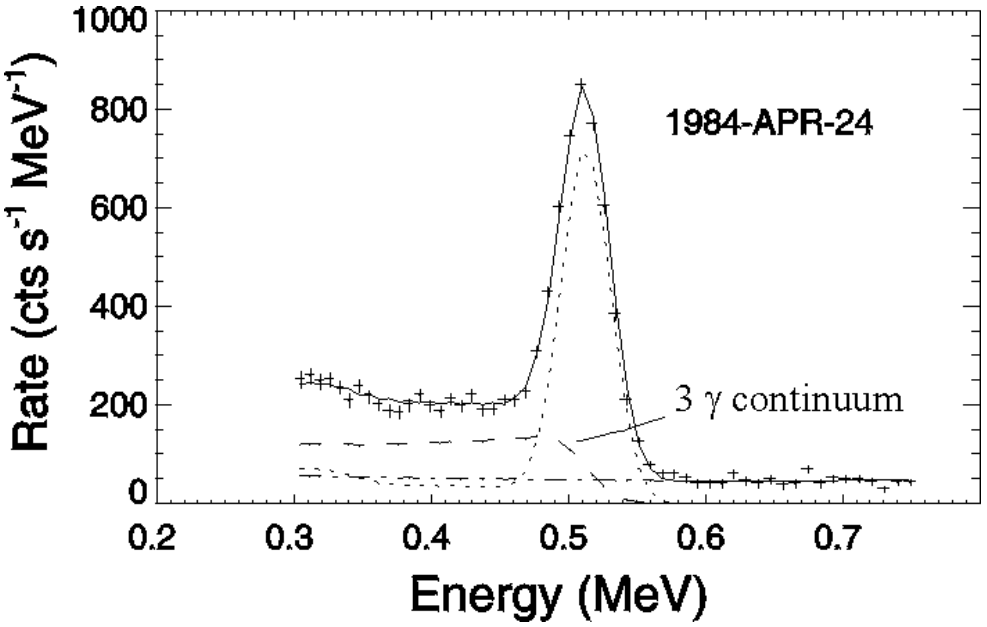
Positronium annihilation results in 2 or 3 γ's depending on ambient density.

Line width yields information on temperature and density.

Good spectral resolution needed to separate line, continuum, and α–α fusion lines.

Measurements of some *SMM* flares have been performed.

***HESSI* measurements are required.**

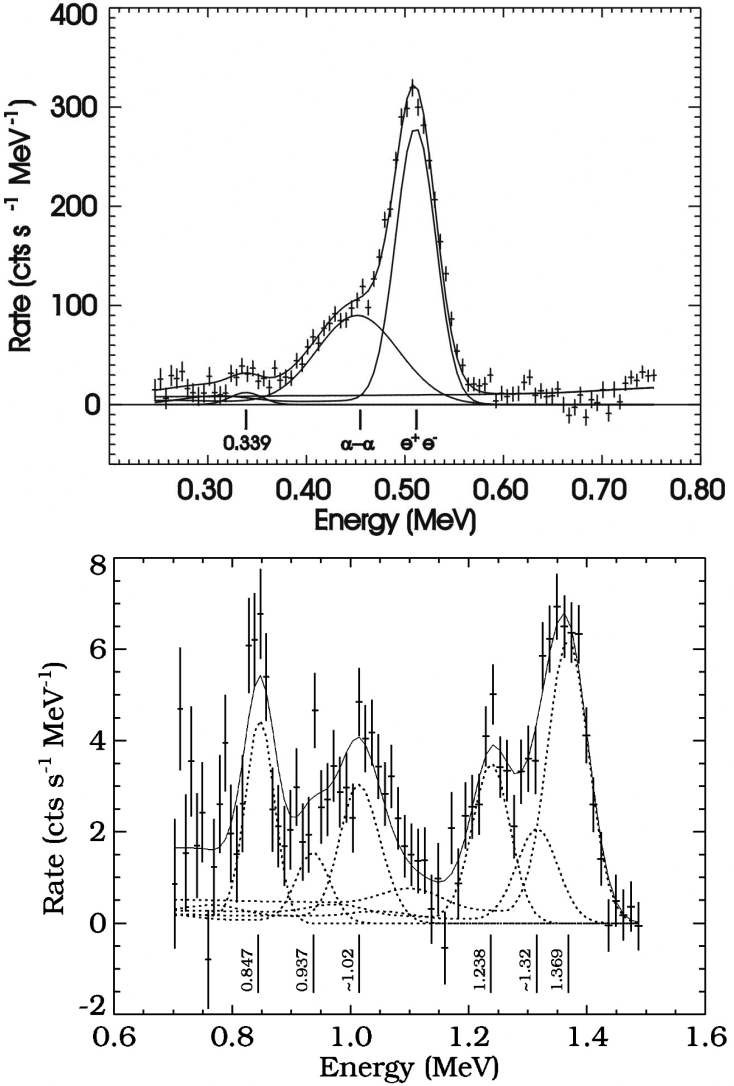


Helium Abundance from γ–Ray Line Spectra

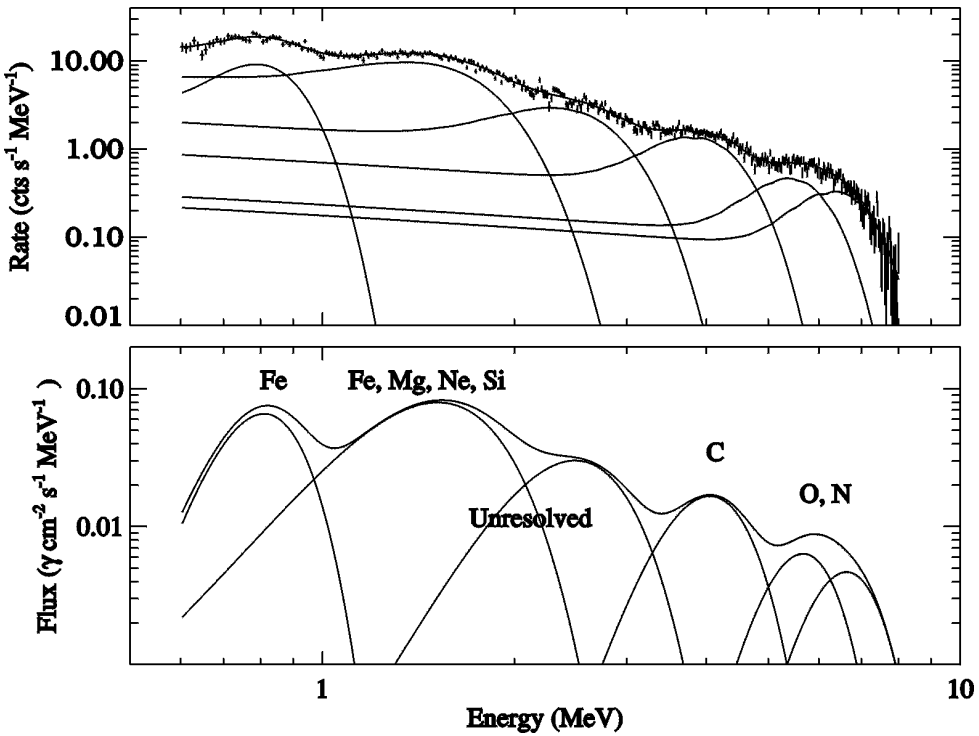
Relative intensity of the α–α line feature suggests either enhanced accelerated α/p ratio or enhanced ambient He/H ratio at the flare site.

Intensities of lines at 0.339 and ~1.03 MeV from α–^{56}Fe can discriminate between the two. There are other lines near 1.03 from p and ^{3}He interactions on C & O that complicate the situation. A line near 0.937 MeV is also expected from the ^{3}He interaction.

Study of 19–flare average suggests enhanced α/p and evidence for ^{3}He/^{4}He at levels near 0.1 (Share & Murphy (1998). Study of individual flares suggest that ambient He/H can also be enhanced and that ^{3}He/^{4}He can be as high as ~1 (Mandzhavidze et al. 1999) . ***HESSI*** observations are key!



Gamma-Ray Spectrum from Accelerated Heavy Ions



Residual spectrum after subtracting contributions from bremsstrahlung and narrow lines reveals broadened lines from accelerated ions.

Best fit to spectrum contains six Gaussian features that can be identified with different ions.

Fe and C are resolved. The Fe, Mg, Ne, and Si lines between 1 – 2 MeV cannot be resolved.

Major uncertainty is the shape of the 'unresolved line' component that is expected to peak in the 1 – 3 MeV region.

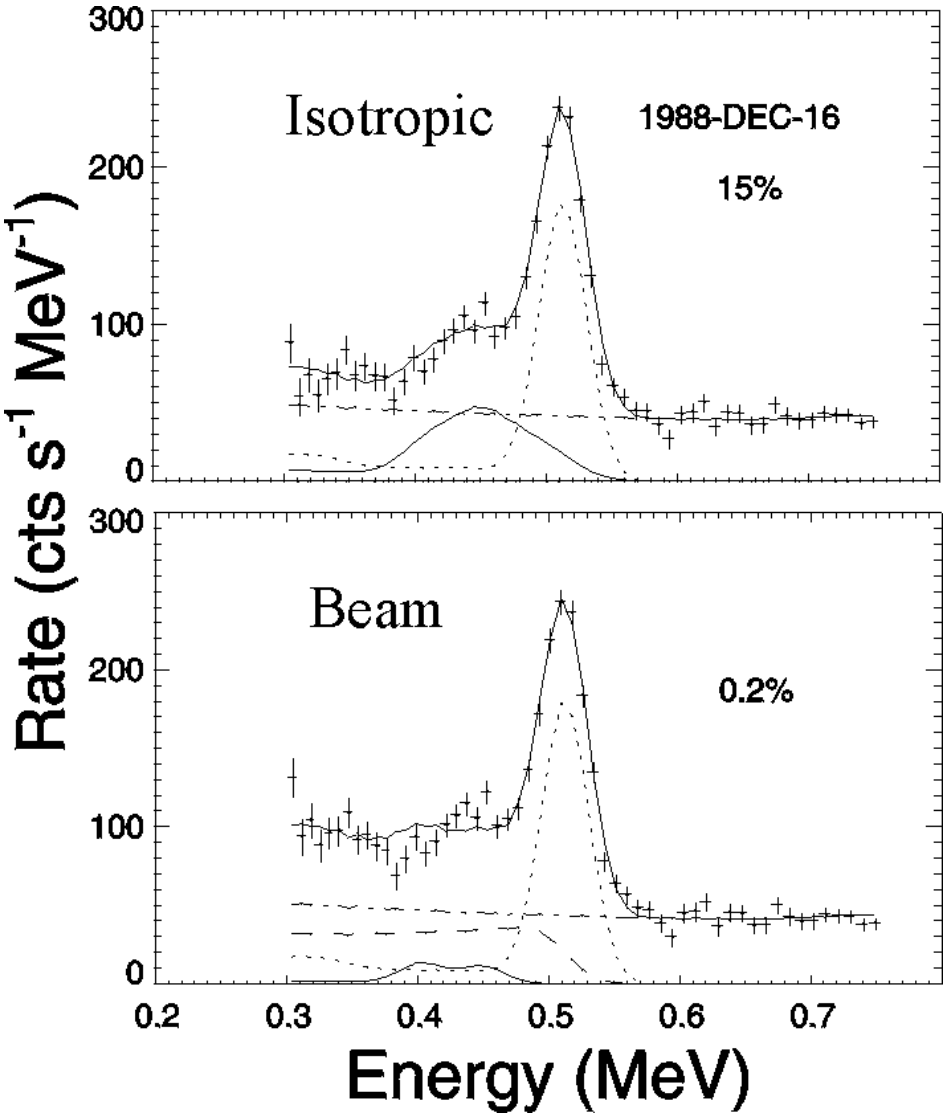
Directionality of Alpha Particles

Line shape of α–α fusion lines in two flares is inconsistent with a downward beam and is consistent with isotropic or fan-beam distributions.

Width may be narrower and shifted in energy relative to isotropic model. Comparison with improved models important.

A downward isotropic distribution is marginally consistent with the data.

***HESSI* measurements will clarify the directionality of accelerated α-particles.**



Evidence for Anisotropic Particle Distribution in Flares

Fitted energies of the carbon, oxygen, and neon de-excitation lines vs cosine of heliocentric angle of flares observed by *SMM*. No significant shift is seen in the neutron capture line. Indicates accelerated particles preferentially interact in the downward direction.