

^{26}Al spectroscopy

Structure & kinematics in the inner Galaxy

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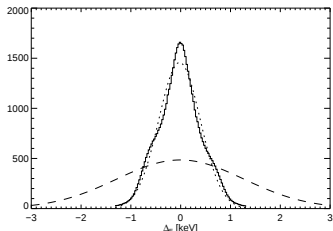
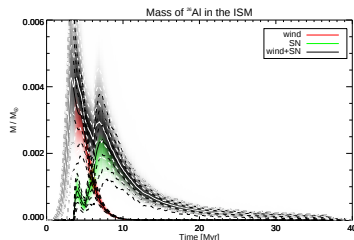
MPE Gamma group

Five Years of INTEGRAL, 2007-10-17

Origin of the ^{26}Al line shape

The shape of the ^{26}Al line at 1.8 MeV contains information about the source kinematics.

- Expectations:
 - Galactic rotation
 - Hot interstellar medium in massive star environments
- width of ≈ 1 keV from the inner Galaxy.
- We use different approaches to test models:
 - Measurement of the line shape obtained by spatial model fitting
 - Measurement of the line position for different areas on the sky

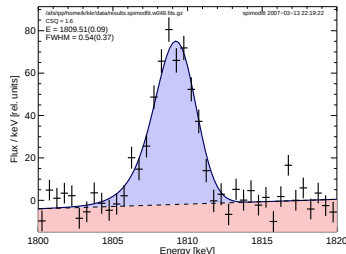


Generating a SPI spectrum

- Inner Galaxy ^{26}Al 1.8 MeV spectrum assuming the spatial distribution measured by COMPTEL
- Spatial model fitting

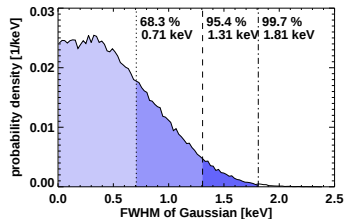
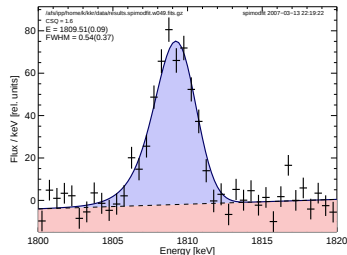
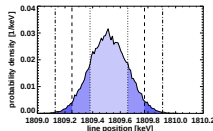
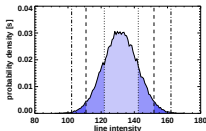
$$D = \int \alpha \cdot S \cdot R + \beta \cdot B$$

- S sky model
(COMPTEL map)
- R instrument response
- B background



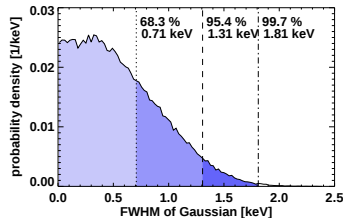
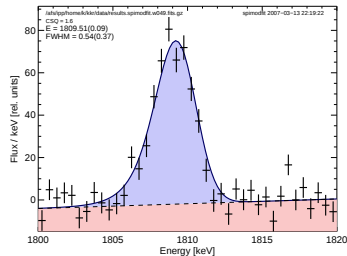
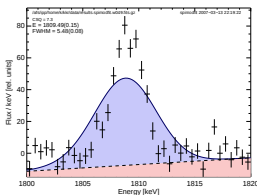
Analysing a SPI spectrum

- Spectrum from spatial model fitting analysed with a spectral model
- Spectral shape from averaged spectral response (derived from instrumental lines) + parameterised intrinsic width of sky emission
- Fit results: probability distributions determined via Markov Chain Monte Carlo

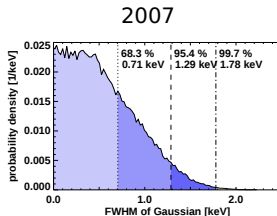
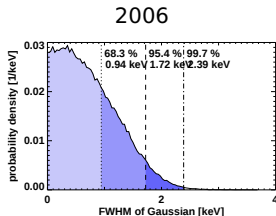
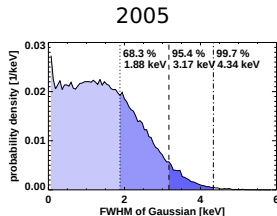


Width of the ^{26}Al line

- → probability distribution for the intrinsic width
- Line is narrow ($< 1.3 \text{ keV}$ @ 95 % CL)
- GRIS result ($5.4[+1.4,-1.3] \text{ keV}$) incompatible at relative probability of 410 dB $\approx 13.5 \sigma$



Width limits over time

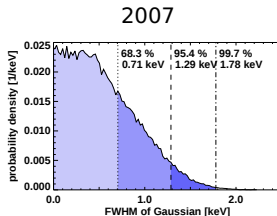
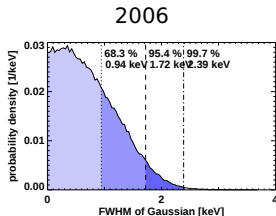
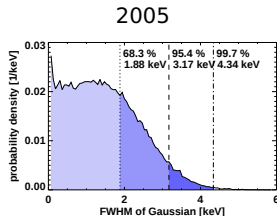


- Limits become stricter with accumulating data

Year	95.4 % UL
2005	3.17 keV
2006	1.72 keV
2007	1.31 keV

Future?

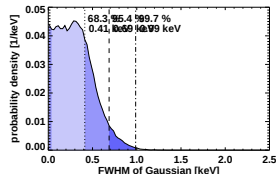
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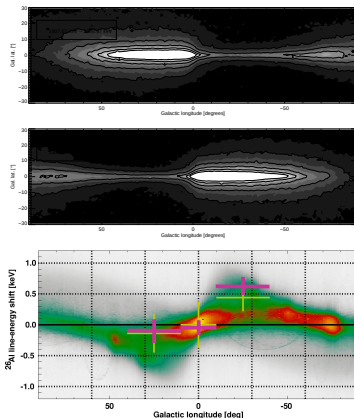


Spatially resolved spectroscopy

tests the variation of ΔE with galactic longitude

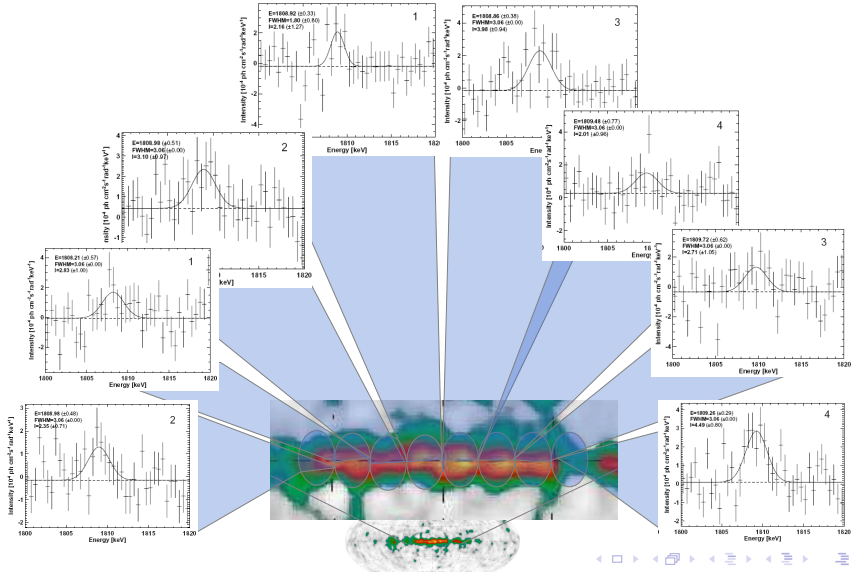
Fitting multiple models simultaneously makes better use of SPI's spatial resolution than using only a single map.

- Slices from a 3-D spectral model $[I(l, b, E)]$ along energy intervals
→ maps from model → spectra
from maps for red-/blueshifted emission
- Slices from a sky map, e.g.
intervals of Galactic longitude



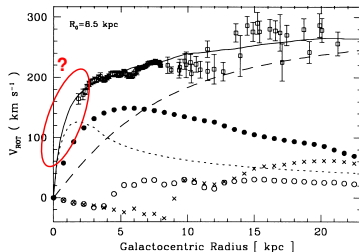
Resolving the inner Galaxy

10° segments still marginal

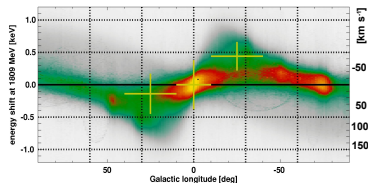
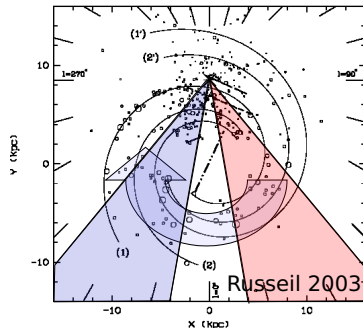


Rotation in the inner Galaxy

- Rotation curve not well determined from HI inside of $2 \text{ kpc} \approx 15^\circ$
→ fill the gap



Olling & Merrifield 2000



Summary

- SPI's fine energy resolution
 - measure ISM velocities down to $\approx 50 \text{ km s}^{-1}$
 - bulk motion vs. turbulence
- SPI's spatial resolution ($\approx 3^\circ$)
 - Line shift as a function of galactic longitude
 - Resolve structure of the inner Galaxy (bar, ...)

