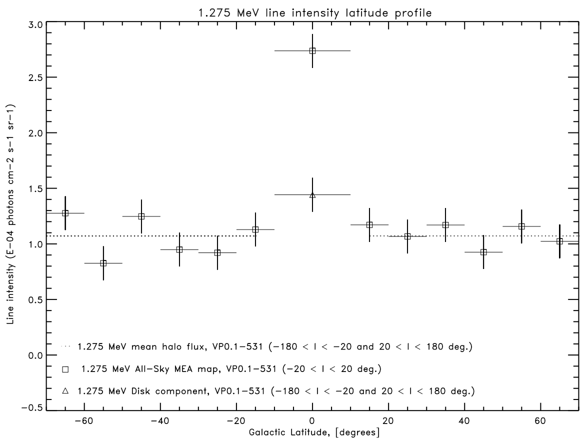
Galactic Bulge Seen in 1.275 MeV γ-Ray Line

Classical novae (CNe) are believed to be the source of the ISM enrichment with the isotopes of ^{13}C, ^{15}N, ^{22}Na and ^{26}Al. The latter two, especially radioactive ^{22}Na with life-time of 3.75 yr, which decays producing 1.275 MeV γ-ray photon, could be used as a probe of the nova thermonuclear runaway theory (TNR). We have used a two-way approach to understand nova TNR, namely: (1) – by attempting the ^{22}Na line emission detection from individual novae; and (2) – by deriving the ^{22}Na line emission global galactic distribution. In contrast to other wavelengths, in the γ-ray band the Galaxy is almost transparent, so that otherwise obscured bulge novae may be detectable up to $A_v \sim 10^3$ in γ-ray line emission. This allows us to directly measure the bulge novae rate by comparing observations of the individual Galactic novae with the measured integrated ^{22}Na line emission from the bulge population.

The COMPTEL telescope that operated between 1991 and 2000 on board the Compton Gamma-Ray Observatory (CGRO), thanks to its unique combination of imaging and spectroscopic capabilities, accumulated in 9 years of CGRO life-time a priceless database that for the first time enabled us to detect bulge extended emission in 1.275 MeV γ-ray line (see Iyudin et al., AIP-587, 508 (2001) and Figure below).



Latitude profile of the galactic bulge region in the 1.275 MeV line is shown by squares for the combination of all observations. The disk component outside the bulge is shown also by a triangle. A dotted line shows mean intensity in the 1.275 MeV line of the galactic halo. Intensity is in units of $10^{-4}\ phot.cm^{-2}s^{-1}sr^{-1}$.

- Assuming the yield of ^{22}Na in nova is between $3\times10^{-9}\ M_\odot$ and $1.2\times10^{-8}\ M_\odot$ as was modelled by Jose et al. (1999) we derive the range for the classical nova rate (R_{CN}) in the Galactic bulge as,
  20.5 yr$^{-1} \leq R_{CN} \leq$ 82 yr^{-1},
  where the lower bound value is close to the usually quoted (Della Valle and Livio 1998).
- Further assuming that Galactic bulge novae comprises ~75 % of all Galactic novae similar to the case of M 31, we evaluate the space density of active classical novae systems in the bulge, namely
  1.4×10^{-5} pc$^{-3} \leq D_{CN}$ pc^{-3},
  i.e. more than order of magnitude higher than the value favoured by Patterson (1984).
- The above considerations do not exclude the possibility that part of the detected 1.275 MeV line emission in fact results from ^{22}Ne excitation by low-energy cosmic rays in the Galactic bulge. If this is the case, then a notable part of the hard X-ray emission in the Galactic ridge detected by GINGA, ASCA, and Chandra might be produced by the same cosmic rays interacting with the bulge gaseous matter.

Summary:

- COMPTEL's 1.275 MeV line intensity profiles point toward a bulge shape with the ratio of the major-to-minor bulge axis of ~2. This bulge shape is consistent with the bulge model derived from the COBE measurements of the Galactic IR-emissivity (Dwek et al. 1995).

References:

1. Iyudin A.F., et al., AIP CP-587, 508 (2001).
2. Dwek E., et al., ApJ, **445**, 716 (1995).
3. Jose, J., Coc, A., & Hernanz, M., ApJ, **520**, 347 (1999).
4. Della Valle, M. & Livio, M., ApJ, **506**, 818 (1998).
5. Patterson, J., ApJS, **54**, 443 (1984).

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