Diffuse Galactic Emission

Some (random) notes

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Diffuse Group Parallel Session
Some of these issues addressed in forum on

confluence.slac.stanford.edu/display/SCIGRPS/Ideas+for+Discussion+Diffuse

Some topics addressed here *seem* not to have been discussed in this group much previous to this.
REMARK

Diffuse is a problem for sources
Sources are a problem for diffuse

--> *have to solve simultaneously*

(cf hard X-rays where sources dominate 10 : 1)
Sources and Diffuse

Detected sources
Include sources in analysis, *don't try to 'subtract' sources!*
Input catalog(ue) positions and fit all source fluxes along with model.
Then can plot spectrum of diffuse alone.
(this method is well tried for INTEGRAL for 100's of sources)
Guarantees consistency.

Unresolved source populations
1. *Known* populations like pulsars, SNR which can be
   modelled with some degree of precision (e.g. by Alice)

2. *Unknown* populations of sources
   e.g. large numbers of weak sources which may be completely undetected.

Need to put constraints based on logN-logS & sky distribution.
In low luminosity/high density limit:
   nearest sources isotropically distributed on sky (cf stars)
REMARK

For source population analyses, can (& should) go down to much lower significance limit than for catalogues.

But then have to treat the statistics correctly.
**galprop development**

**galprop** status: see Igor’s presentation at the May meeting.

Ideas for **galprop** future:

1. Need for new start version profiting from 10 years of experience in how to approach the subject and of c++.
2. Chance to find bugs and introduce new ones.
3. More modular architecture to allow plug-ins.
4. Should start from design document rather than *ad hoc* development as was done for current version.
5. Data formats have to be compatible with GLAST (not yet the case).
6. 64-bit code (required for 3D modelling)
7. Documentation (currently very incomplete)

**BUT ALSO**

8. Keep supporting/developing current version also, since a new start is a big project. Current version widely used in community.

In both cases, need pure c++ (current version still has some fortran subroutines !)
**galprop future development**

1. pion-decay physics (Tune): really *have* to get it right!

2. new ISRF for IC (Troy Porter)

3. anisotropic IC scattering: review implementation

4. new HI, CO maps as $f(R)$ (Seth); GC gas: special modelling needed

5. “dark gas” ?? : how to handle it (see Isabelle's presentation)

6. dark matter : overlap with DM group, but must have it in *galprop*

7. magnetic fields (electron energy loss, sync. radiation)
   at present use very simple function $B(R,z)$
   but a lot is going on in radioastronomy and theory eg *astroph/0508485*
   new radio surveys 10 Mhz-100 GHz: essential constraints on electron spectrum
plotting and fitting is not part of current public galprop package but is done in separate program galplot for our papers (shares all galprop classes and uses root)

most users make their own plots, reading the galprop FITS output files.

galplot has become a big program, able to combine data from different missions (INTEGRAL, RXTE, COMPTEL, OSSE, EGRET ..... and is not at all trivial (e.g. convolutions, different regions observed)

Fitting required for models:
* global normalizations of gamma-rays to model: since proton, electron spectra normalizations free (within limits).
* EGB, $X_{CO}$

Development of equivalents for GLAST is a big job but essential.
galplot example

galdef ID 47_600203a

RXTE INTEGRAL
COMPTEL  EGRET

galprop model
galplot example

galprop model
REMARK

The overlap between the analysis groups
catalogues / sources / diffuse / dark matter

is so large that some global planning
of interfaces is required
( Presumably is going on but hard to find info. )

e.g.
catalogues are input to diffuse analysis
diffuse model are input to catalogues
diffuse models provide background for dark matter
Burning Questions

on Galactic diffuse that we should / can answer within a year of start, without very deep analysis.

1. GeV excess: exists really? how big?
2. spectrum 10 - 100 GeV (EGRET gave tantalizing hints)
3. source contribution: is it as small as we thought?

More difficult without deep analysis:
4. Xco(R)
6. dark gas
7. EGB
8. local regions like Orion
Interstellar radiation field

for inverse Compton & electron energy loss

need: spectrum of optical, infrared over Galaxy in 3D

galprop ISRF computed about 10 years ago,
Now lots of new information from eg COBE, WMAP, 2MASS
Galactic structure, stellar model atmospheres.

Huge job to make use of all that!

Complete new computation by Troy Porter
Self-consistent optical/IR, with radiative transfer.
Brief summary in astroph/0507119, full paper in preparation.
Now available for galprop, but work continues. e.g.
for anisotropic IC scattering need also angular distribution
of ISRF at every point: under construction.

The good news: old ISRF was not bad!
Example ISRF

- 2D RF calculated for
  - $R_{\text{max}} = 20 \text{ kpc}$
  - $Z_{\text{max}} = 5 \text{ kpc}$
  - $\Delta R = 1 \text{ kpc}$
  - $\Delta Z = 0.1 \text{ kpc}$
- Scattered light $\sim 10\%$
- Upper panels: Optical (blue), IR (red), Total (black)
- Lower panels: RF at different $R$ ($z = 0 \text{ kpc}$)
  - and different $z$ ($R = 0 \text{ kpc}$)
Local ISRF spectrum

Black : Mathis (1983); Green : Wainscoat (1992); Blue : GalProp + arms; Red : GalProp + bulge + arms

Green : Wainscoat (1992) + IR; Blue : GalProp + arms + IR; Red : GalProp + bulge + arms + IR; Magenta : DIRBE; Yellow : FIRAS
(data courtesy D. Finkbeiner)