

Gamma-ray White Paper Discussion Notes

Liz Hays

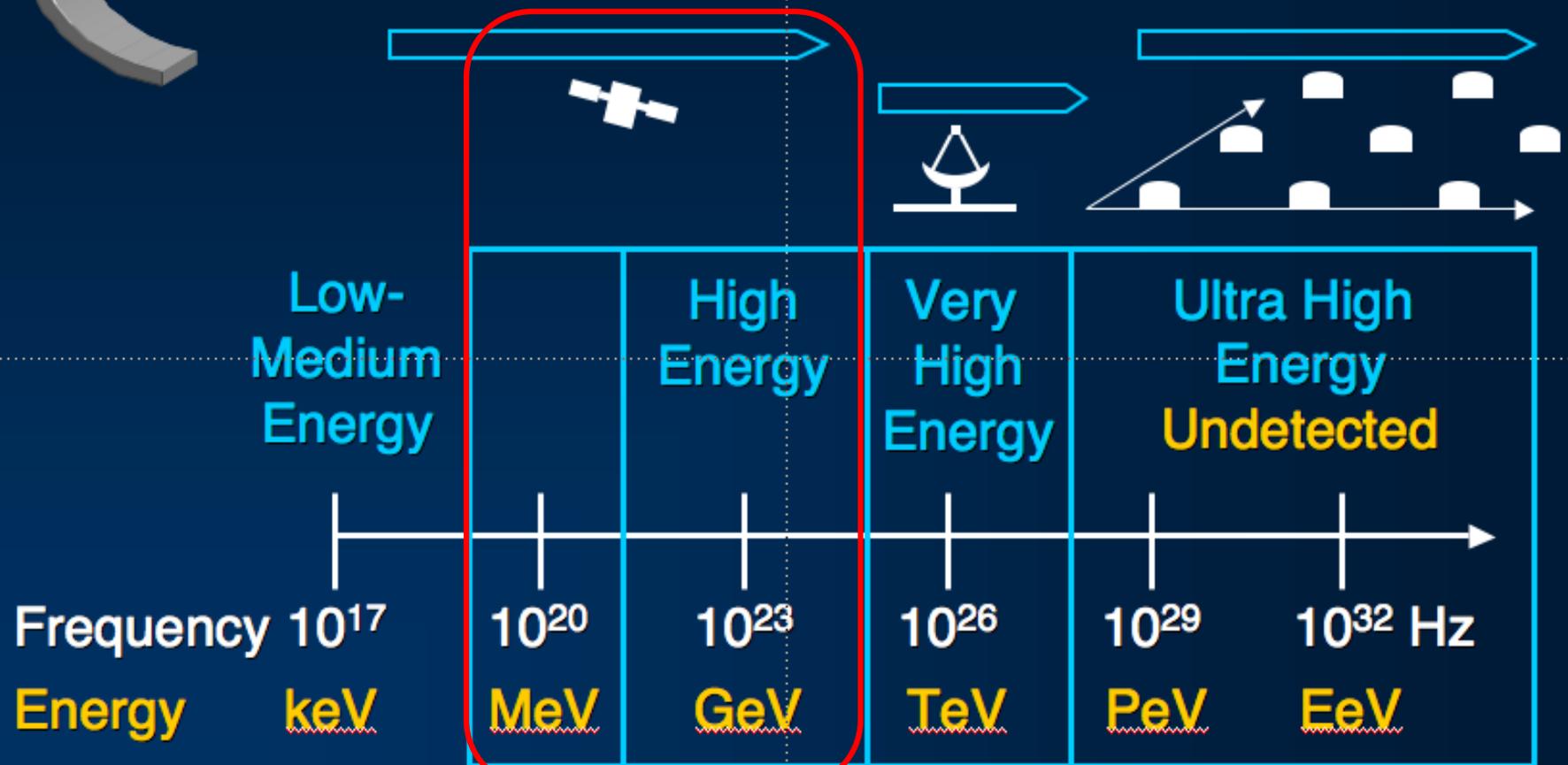
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PhysPAG: GammaSAG session

Broad and vital science!

- Need to make this accessible and understandable beyond the gamma-ray community

The gamma-ray spectrum



Where do we draw the line?

- For GammaSAG?
- For the white paper?

Possible White Paper Organization

- Gamma-ray Science Objectives
 - Open questions for gamma rays
 - Connections to PCOS objectives, decadal science
 - Context
 - Complementarity to other wavebands
 - Synergy with ground-based facilities
 - Multi-messenger connections
- Technology
 - Split on wavelength?
 - Need to map technology to science

PCOS Science

- Physics of the Cosmos spans the fields of high-energy astrophysics, cosmology, and fundamental physics, and includes a wide range of science goals. These include the following:**
 - Expand our knowledge of dark energy**
 - Precisely measure the cosmological parameters governing the evolution of the universe and test the inflation hypothesis of the Big Bang**
 - Test the validity of Einstein's General Theory of Relativity and investigate the nature of spacetime**
 - Understand the formation and growth of massive black holes and their role in the evolution of galaxies**
 - Study the origin and acceleration of cosmic rays**
 - Particle Signals of Dark Matter**

The screenshot shows the NASA website page for 'Physics of the Cosmos Projects'. The page is organized into several sections:

- Overview:** Includes links for Documents, PhysPAG, CDR Program Office, CDR Office, and Multimedia Library. It also has a sign-up for PCOS News and Announcements.
- Operating Missions:**
 - Chandra X-ray Observatory:** Launched 23 July 1999. The Chandra X-ray Observatory, a NASA Great Observatory, provides the most detailed view to date of the X-ray universe. With its exquisite imaging capabilities and high spectral resolution, scientists have investigated phenomena as diverse as the spectra of Jupiter's aurora, the effects of dark energy on the growth of galaxy clusters, and the properties of faint x-ray sources in deep fields.
 - Fermi:** Launched 11 June 2008. The Fermi Gamma-ray Space Telescope (formerly GLAST) is providing the deepest and most detailed map of the gamma-ray sky. Fermi has recorded high-energy gamma rays produced by supernovae, pulsars, extreme flows of energy from systems powered by black holes, and gamma-ray bursts.
 - Planck:** Launched 14 May 2009. Planck Surveyor is an ESA-led mission that is making a precise, full-sky map of the Big Bang's cosmic microwave background (CMB). By measuring minute fluctuations in the CMB temperature and polarization at all angular scales, Planck will stringently test the theory of inflation, and will provide the most accurate information to date on the overall composition, shape, and early expansion history of the universe.
 - XMM-Newton:** Launched 10 Dec 1999. XMM-Newton, the X-ray Multi-Mirror Mission, is the second cornerstone of the ESA Horizon 2000 program. With high collecting area in the x-ray band, XMM provides vital information for studies of fundamental and relativistic processes from neutron stars and active galactic nuclei, the creation and dispersal of the elements in supernovae, the distribution of dark matter in clusters, groups, and elliptical galaxies, and young active stars to constrain models of the early solar system and star forming regions.
- Program News:**
 - 5 January 2012:** CDR's Agency for PhysPAG Meeting at AAS of Austin, Texas, is posted.
 - 21 December 2011:** X-ray Mission Workshop presentations are posted.
 - 1 December 2011:** Physics of the Cosmos Newsletter is available.
 - 1 December 2011:** PCOS Program Annual Technology Report (PART) now available.
- Project News:**
 - 17 November 2011:** Chandra News: NASA's Chandra AG22 to Rank Hot Spots.
 - 28 November 2011:** Fermi News: On the Hunt for Cygnus, NASA's Fermi Reveals a Charming Cosmos.
 - 27 April 2011:** Planck News: Aesthetically pleasing in many colors.
 - 7 October 2011:** XMM-Newton News: XMM-Newton AG-11 Subscription Closed.
- Related Missions News:**
 - 28 October 2011:** RACE News: RACE Special Session at January 2012 AAS Meeting: Abstract Deadline.
 - 1 September 2011:** Suzaku News: Suzaku AG-7 Proposals Due on Nov 15, 2011.
 - 25 October 2011:** Swift News: New, There's an App for NASA's Swift Observatory.
- Previous Missions:** (Section header visible at the bottom of the page)

Key Science Questions from New Worlds New Horizons

Galactic Neighborhood	GAN 1	What are the flows of matter and energy in the circumgalactic medium?	Stars and Stellar Evolution	SSE 1	How do rotation and magnetic fields affect stars?	Time surv
	GAN 2	What controls the mass-energy-chemical cycles within galaxies?		SSE 2	What are the progenitors of Type Ia supernovae and how do they explode?	
	GAN 3	What is the fossil record of galaxy assembly from the first		SSE 3	How do the lives of massive stars end?	
Galaxies Across Cosmic Time	GCT 1	How do cosmic structures form and evolve?	Cosmology and Fundamental Physics	SSE 4	What controls the mass, radius, and spin of compact stellar remnants?	Gra astr
	GCT 2	How do baryons cycle in and out of galaxies, and what do they do while they are there?		CFP 1	How did the universe begin?	
	GCT 3	How do black holes grow, radiate, and influence their surroundings?		CFP 2	Why is the universe accelerating?	
	GCT 4	What were the first objects to light up the universe, and when did they do it?		CFP 3	What is dark matter?	
				CFP 4	What are the properties of neutrinos?	

Questions for Gamma-ray Science

Fermi mission objectives, as one example

- Explore the most extreme environments in the Universe, where nature harnesses energies far beyond anything possible on Earth.
- Search for signs of new laws of physics and what composes the mysterious Dark Matter.
- Explain how black holes accelerate immense jets of material to nearly light speed.
- Help crack the mysteries of the stupendously powerful explosions known as gamma-ray bursts.
- Answer long-standing questions across a broad range of topics, including solar flares, pulsars and the origin of cosmic rays.

Key Questions?

Complementarity

- Crucial in current funding situation
- With other SAGs
 - Cosmic-ray SAG (a close cousin!)
 - XRSAG (the nonthermal universe)
 - GWSAG (extreme physical environments)
 - COPAG (radioactive nuclei)
- With other mission ideas/measurements
 - Gamma rays often provide complementary views, e.g., extragalactic background/star formation

Resources: Not starting from scratch!

- Variety of relevant contributions to the Astro 2010 Survey, mission concept studies
 - Currently building a reference list of papers and links to capture the core of the field

The \$\$\$ Slide

- What goals of gamma-ray science can be addressed, partially addressed, or significantly advanced at smaller mission scales?

Future Needs

- Technology
 - Risk and readiness
 - How can we improve proposal cost estimates and support success of smaller scale efforts
 - Impact: Enabling, enhancing, important
 - What are community priorities?
 - Map to science goals
 - An important output of this group is providing input to PCOS on technology needs

Path Forward

- Who?
 - Looking for general contributors and section leads
- When?
- Cadence for telecons?