Highligths of Vulcano Workshop 2006:

(a personal view)

G. Auriemma Università degli Studi della Basilicata and INFN Sezione di Roma "La Sapienza"



N. Panagia: Reionization of IGM

- Mission JWST
 - End of the Dark Ages
 - Determine the space density, energy source, and physical characteristics of the first luminous objects from z~20 up to the epoch of reionization.
 - Assembly of Galaxies
 - Understand the structural and chemical evolution of galaxies, AGN and the intergalactic gas and their interplay from the epoch of reionization to $z \sim 1$.
 - Formation of Stars and Stellar Systems
 - Unravel the birth and early evolution of stars, from infall onto dustenshrouded proto-stars to the genesis of planetary systems.
 - Planetary Systems and the Conditions for Life
 - Determine the physical and chemical properties of planetary systems, including our own, and investigate their potential for life.

Quantum gravity

- S. Liberati
 - Astrophysical tests of Lorentz invariance
 - Time of flight & Birifrangence
 - Shift of standard thresholds reactions (GKZ)
 - Search for QG imprint on initial cosmological perturbations
 - CPT violations induced by Lorentz Invariance violating terms can also produce baryon asymmetry

Dark Matter and Dark Energy

- R. Bernabei: Direct search → DAMA @ Gran Sasso → modulation
- S. Colafrancesco Theoretical & Experimental searches
 - Limits on direct & accelerator searches \rightarrow comparison
 - Perspective for indirect searches
- F. Fucito: DM & Extra dimensions
 - SUSY good & bad properties
 - String models with large transverse dimensions, which can achieve unification at TeV scale
 - Interesting perspectives from the bottom-up scenario

• S. Capozziello: Modified GR vs. DM & DE

- Do we need dark matter and dark energy?
- No, if we are allowed to modify gravity.
- Old MOND theory by Milgrom (1983) is unsatisfactory (e.g. angular momentum would be not conserved)
- A field theory (TeVeS) (Bekenstein with an "ad hoc" covariant scalar field
- In this paper a new proposal:
 - Action density of $GR \propto R^{4/3}$
- Need to be tested
 - Weak fields
 - Gravitational waves
 - Birkhoff theorem

Missing baryons problem

- Y. Takei "Hot and cold ISM"
 - According to a recent paper of Nicastro *et al.* soft X-ray spectroscopy reveals that 90% of baryons are in the form of WHIM gravitationally trapped by filaments of DM, as predicted by <u>simulations</u>.
 - This conclusion has been disputed by Far UV spectroscopists (Collins et al. 2004, Sembach 2004)
 →High velocity clouds
 - To search and study the WHIM is very interesting theme.
 - z>0 WHIM was detected.
 - Since the distribution of the WHIM could reflect that of dark matter, study of the WHIM is essential to understand the real structure of the universe.

Neutrinos

- A. Ereditato: High precision v oscillations
 - Neutrino mass is the first solid indication for physics beyond SM.
 - In the SM ν is massless because mass term mix r.h. components and l.h. components.
 - Smallness of neutrino masses finds a natural explanation in the see-saw model → Massive Majorana neutrinos M_N ≈10¹² GeV → Ideal range for Leptogenesis
 - CP violations in the leptonic sector → Perhaps not too far away for Long Baseline Oscillation experiments !

CP Violations

- V. Sharma: CP violations in B decays
 - CP violation is one of the essential ingredients for dynamical baryogenesis
 - All experimental results up to now confirm the CKM model of CP violations in the framework of the SM
 - B, C and CP violations at the EW phase transition could qualitatively explain the observed baryon asymmetry
 - SM fails to produce the observed asymmetry because:
 - 1. CKM CP violations vanish above the EW phase transition where B-violating transition are active
 - 2. The EW phase transition is not strongly 1st order
 - MSS extension of the SM could produce baryogenesis, but...
 - ... New Physics in CP violations should be observed.

- D. Denegri LHC and the Universe
 - Progress on LHC construction
 - Progress on CMS construction
 - connection with cosmic rays physics
 - Quark-Gluon Plasma
 - SUSY Dark Matter
 - Extra dimensions
 - (CP violations)
- Perhaps the biggest effort untill now to push the limits of the physical knowledge of the Cosmo backward in time !

Many thanks to the organizers of this very successful meeting

Thanks for Your attention!

G. Auriemma Photo Courtesy of E. Shaviv Concluding Remarks - Vulcano Workshop 2006



DM direct search: results

[James Pinfold - ISMD 2005]



Constraints on χ physics



G. Auriemma

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Warm-hot intergalactic medium (WHIM)

- T ~ 10^{5} - 10^{7} K; n_H~ 10^{-4} - 10^{-6} cm⁻³
- Most plausible candidate of `missing baryon'
- Form a filamentary structure along dark matter
 - Best object to study dark matter distribution



