

Cosmic Frontier Organization and Activities

CPM 2012

S. Ritz, J. Feng
on behalf of the Cosmic Frontier group

11 October 2012



Groups

- All
- Energy Frontier
- Intensity Frontier
- Cosmic Frontier
- Frontier Capabilities
- Instrumentation
- Frontier
- Computing Frontier
- Education and Outreach

Google Search

www.snowmass2013.org

WWW

Cosmic Frontier

Conveners: Jonathan Feng (UC Irvine), Steve Ritz (UC Santa Cruz)

ANNOUNCEMENTS

August 3, 2012: Subgroup Conveners are now posted. Many thanks to all who provided inputs and especially to all those who have agreed to serve as conveners.

June 20, 2012: We are currently soliciting community input for subgroup conveners, topics, and experiments (see below).

CHARGE

The Cosmic Frontier working group is charged with summarizing the current state of knowledge and identifying the most promising future opportunities at the interface of particle physics, astrophysics, and cosmology. Topics include dark matter, dark energy, the matter-anti-matter asymmetry, cosmic particles, and astrophysical probes of fundamental physics.

ORGANIZATION

The work of the Cosmic Frontier is divided into 6 subgroups. They and their conveners are:

- CF1: **WIMP Dark Matter Direct Detection** (Priscilla Cushman, Cristian Galbiati, Dan McKinsey, Hamish Robertson, Tim Tait)
- CF2: **WIMP Dark Matter Indirect Detection** (Jim Buckley, Doug Cowen, Stefano Profumo)
- CF3: **Non-WIMP Dark Matter** (Alex Kusenko, Leslie Rosenberg)
- CF4: **Dark Matter Complementarity** (Dan Hooper, Manoj Kaplinghat, Konstantin Matchev)
- CF5: **Dark Energy and CMB** (Sarah Church, Scott Dodelson, Klaus Honscheid)
- CF6: **Cosmic Particle Probes of Fundamental Physics** (Jim Beatty, Ann Nelson, Angela Olinto)

The subgroups are led by expert experimentalists and theorists in each area. A "high-minded observer" may also be appointed to some subgroups. The linked subgroup webpages list relevant topics and experiments for each subgroup. In addition, many topics cut across more than one Frontier; overlaps requiring the collaboration of two or more working groups are also noted.

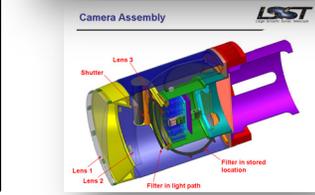
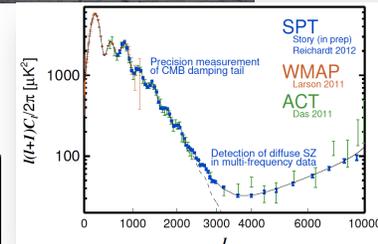
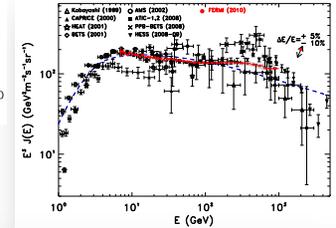
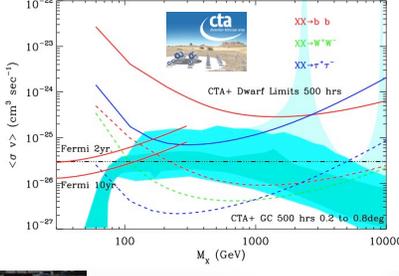
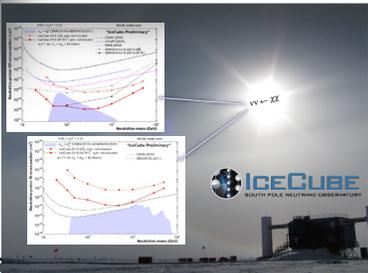
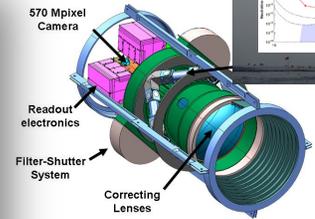
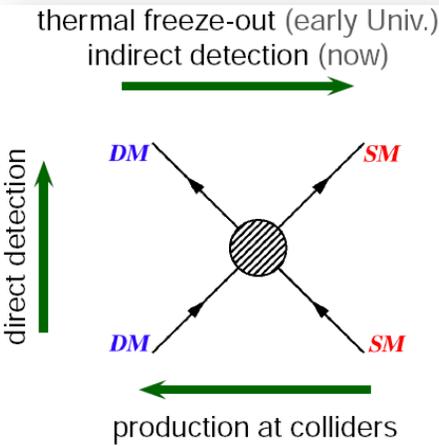
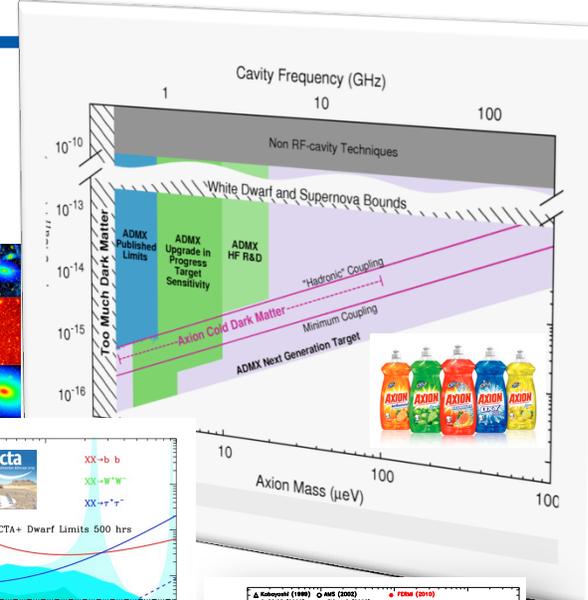
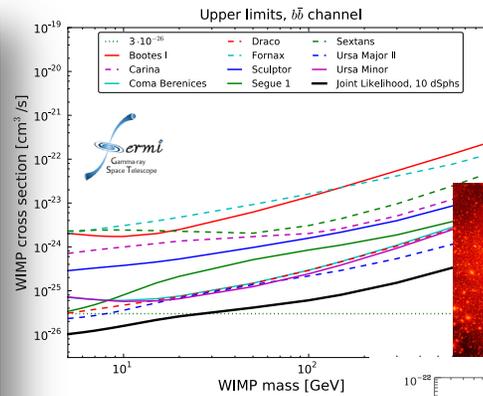
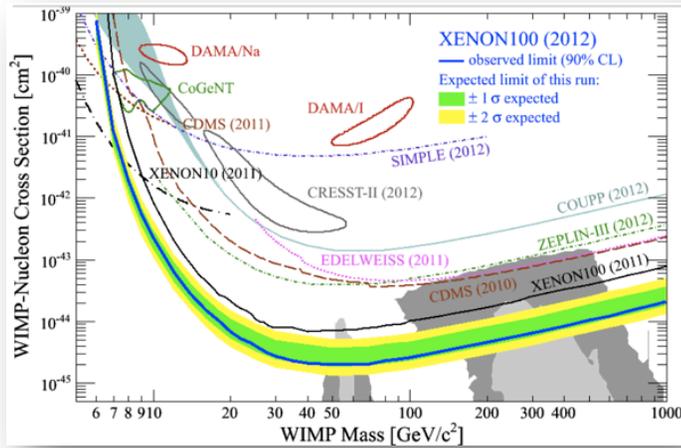
Several cross-cutting, ongoing discussions will be organized by the relevant subgroup conveners. For example, we anticipate having a regular **Dark Matter Forum** to connect people working in the subgroups.

Suggestions for additional topics and experiments that are currently missing from the subgroup descriptions are welcome. Please send comments and suggestions to the appropriate subgroup conveners. Please also feel free to use the Forum, which is linked below, so that others can follow the discussion.

USEFUL LINKS

- Previous Prioritization Studies and Studies of Specific Topics
 - DOE Community Dark Energy Task Force Report 2012
 - NSF Astronomy Portfolio Review 2012
 - Particle Physics Project Prioritization Panels (P5 2008, 2010)
 - New Worlds, New Horizons and CFP and PAG Panels (Astro2010)
 - Particle Astrophysics Scientific Assessment Group (PASAG 2009)
 - Dark Matter Scientific Assessment Group (DMSAG 2007)
 - Dark Energy Task Force (DETF 2006)
 - Task Force on Cosmic Microwave Background Research (TCR 2005)
- Cosmic Frontier Forum
- Archive of announcements and community inputs

The Cosmic Frontier



Two events passed the selection criteria
2 events / 672.7 days - background (atm. μ + conventional atm. ν) expectation 0.14 events
preliminary p-value: 0.0094 (2.36 σ)

Run119316-Event36556705 Jan 3rd 2012 NPE: 0.6083e04 Number of Optical Sensors 312

Run118545-Event63723562 August 9th 2011 NPE: 0.09283e04 Number of Optical Sensors 354

Two PeV neutrinos @ IceCube

Activities at the Cosmic Frontier are marked by rapid, surprising, and exciting developments

Recent Community Studies, Prioritization

- Particle Astrophysics Scientific Assessment Group (PASAG)
- Astro2010 (NWNH) and related panels
- NSF Astronomy Portfolio Review
- DOE Community Dark Energy Task Force; DETF
- DMSAG
- CMB Taskforce (TFCR)

- ...plus many topical community self-organized groups

PASAG (2009 October)

Introduction and Scope

- Together with the Energy Frontier and the Intensity Frontier, the Cosmic Frontier is an essential element of the U.S. High Energy Physics (HEP) program. Scientific efforts at the Cosmic Frontier provide unique opportunities to discover physics beyond the Standard Model and directly address fundamental physics: the study of energy, matter, space, and time.
- Primary areas covered by PASAG:
 - Dark matter
 - Dark energy
 - Cosmic particles (high-energy cosmic rays, gamma rays, neutrinos)
 - CMB
- Did not cover all areas of non-accelerator physics. Topics not addressed include low-energy neutrinos, low-energy cosmic rays, nucleon decay, tests of gravity and gravitational waves.
- Report based on a snapshot of where the field stands right now.
 - Activities at the Cosmic Frontier are marked by rapid, surprising, and exciting developments.
 - Attempted to provide advice that is durable, but significant new developments – and great surprises – are likely. It is important to be open to significant new directions over the decade.

23 October 2009

PASAG Report

Inherently Interdisciplinary

- Projects at the Cosmic Frontier naturally exist at the boundary between particle physics and astrophysics.
 - Some projects are obviously very close to the core of particle physics; other projects straddle the boundaries between fields and, in some cases, would not happen without significant HEP participation or leadership.
 - » These projects are designed to answer very important scientific questions and, in many cases, have the potential to uncover new directions for particle physics. Our prioritization criteria for HEP investment take into account these issues.
- Necessary to understand in sufficient detail the related astrophysical phenomena:
 - The astrophysics investment is sometimes necessary to realize the particle physics benefit.
 - The relationship is symbiotic: particle physicists have much to offer these important related fields of study and often have a major impact on them. We have much to learn from each other, and there is much we can do together.

Conclusions

- Exciting times are ahead for particle astrophysics!
- Well aligned with the other frontier areas:
 - Example: the same type of dark matter particles may be produced anew in the Large Hadron Collider (LHC), while relic copies are detected both underground at low energy and from outer space at high energy. Each of these will provide a needed piece of the puzzle. This is a particularly exciting time of convergence of theory and experiment, particle physics and astrophysics.
- A strong entrepreneurial spirit providing great discovery potential.
- Cultural differences between scientific communities are not necessarily impediments, but rather reinforcing capabilities enabling important new opportunities.

23 October 2009

PASAG Report

29

“Snowmass 2013” Cosmic Frontier Organization

- CF1: WIMP Dark Matter Direct Detection
- CF2: WIMP Dark Matter Indirect Detection
- CF3: Non-WIMP Dark Matter
- CF4: Dark Matter Complementarity
 - request from agencies: brief document making the case why the different approaches are all needed
- CF5: Dark Energy and CMB
- CF6: Cosmic Particles and Spacetime Physics (see Cosmic Particle Probes of Fundamental Physics)
- In many cases already have clear roadmaps from previous studies (PASAG, Astro2010, DE reports, DM reports,...).
 - an opportunity to assess and articulate the opportunities and issues in each area

Meetings and Activities

- Bi-monthly tag-up with NSF and DOE
 - includes Non-accelerator Frontier Capabilities representative (Gil)
- Regular tag-up all subgroup conveners (every 1-2 weeks)
- CPM
 - see agenda
 - sessions with Instrumentation and Computing
- **Three-day Cosmic Frontier Workshop at KIPAC/SLAC**
 - **6-8 March 2013**
 - Website: <http://www-conf.slac.stanford.edu/cosmic-frontier/2013/>
 - in conjunction with DURA meeting on 5 March
 - Facilities sessions, and discussing Computing sessions
- Additional meetings with subgroup activity, including:
 - Jan 28 – Feb 3 Aspen: CF4 (DM Complementarity)
 - March 22-25 Snowbird: CF3 (Non-WIMP DM)
 - May 13-17 KITP (UCSB): CF4, ...

CF1: WIMP Dark Matter Direct Detection

Conveners: P. Cushman, C. Galbiati, D. McKinsey, H. Robertson, T. Tait

Charge:

1. Review the current motivation for direct searches for WIMPs
2. Summarize the state of direct searches for dark matter.
3. Identify optimal criteria by which Gen-2 proposals for direct dark matter search experiments can be evaluated.
4. Identify new opportunities for direct searches for dark matter.
5. Identify infrastructure common to direct dark matter searches.

Plans

- Fill in the details of the charge
- Create an outline of the work to be done (the “charge” becomes a WBS) Create working groups for each task and begin the jobs
- Draft papers presented at the March Meeting at SLAC
- Feedback from March meeting incorporated in papers.
- Finalized at Snowmass on the Mississippi.

CF2: WIMP Dark Matter Indirect Detection

Conveners: J. Buckley, D. Cowen, S. Profumo

Charge:

- Develop HEP and astrophysics benchmarks for evaluating experiments, summarize complementarity of indirect experiments, evaluate sensitivity.
- Address complementarity with direct and collider experiments by working closely with CF1, CF3, and CF4.
- Future Experiments – Establish scientific case for CTA, Icecube/PINGU and cosmic-ray antimatter experiments
- Theoretical HEP Issues – Survey models, role of Indirect for non-SUSY models, develop generic benchmark models
- Theoretical Astrophysics Issues – Halo profiles, clumpiness of halos, velocity dispersion and effect on uncertainties in DM detection. Survey non DM-backgrounds for different techniques

Plans through March

- Collect community input on March meeting – work toward a clear statement of what would be lost if Indirect Detection were not part of the complete DM program.

plans beyond March

- Distill a plan for Summer meeting from March meeting.

CF3: Non-WIMP Dark Matter

Conveners: A. Kusenko, L. Rosenberg

Charge (more details on the web page):

Focus on the broad class of non-WIMP dark-matter candidates, with the overarching goal to identify the nature of dark matter. The detection strategies are as varied as the kinds of possible candidates.

- summarize the current state of knowledge of this class of dark matter and create a roadmap that seeks to identify its nature.

Beyond the standard model candidates

Experiments and observations: identify key enabling technologies and an R&D path for these searches.

Astrophysics and synergy: explore the model predictions and their implications for the astrophysical observations.

Plans through March: Outcome of CPM'12@FNAL: connect with complementary CF subgroups. Build community interest (emailings, etc.). Initial discussions at “*SnowDARK*”, Snowbird, UT, March 22-25.

Plans beyond March: Build working group activity. Prepare focus document for Snowmass 2013 discussions.

CF4: Dark Matter Complementarity

Conveners: D. Hooper, M. Kaplinghat, K. Matchev

Charge (more details posted on the website)

- *Detection of dark matter particle(s) and measurement of properties at present-day and future colliders.*
- **Complementarity** of information obtained from colliders and astrophysical observations in light of constraints or detections from direct and indirect searches.
- *Inferring properties of the dark matter particle through astrophysical and cosmological observations.*

Plans through March

- Draft summary document (in collaboration with other CF subgroups) for the agencies discussing the complementarity of different search strategies.
- Summarize existing work.
- Identify questions not adequately addressed in the literature and that could be answered by the time of Snowmass 2013. Use Aspen workshop on dark matter (informally) to help formulate these exercises and questions.
- Establish contact with key high energy experimentalists working on LHC dark matter-related searches and key observational astronomers whose work is relevant to identifying the particle properties of dark matter.
- Identify key members of the community who would be interested in contributing to this exercise, including through conversations at the Aspen meeting and the March meeting.

Plans beyond March

- Coordinate work on the questions and exercises identified with involvement from the community.
- Work to ensure adequate representation at Snowmass 2013 meeting to tackle the charge.

CF5: Dark Energy and CMB

Conveners: S. Church, S. Dodelson, K. Honscheid

Charge (see webpages for details)

- Dark Energy
 - survey what will likely be learned; opportunities ground/space; what must be done to reach stage-IV sensitivity
- Modified Gravity
 - main theoretical issues, distinguishing models, scale transition
- Inflation
 - CMB polarization and large-scale structure surveys, parameter space, exploit synergies
- Neutrinos in the Cosmos
 - observations that constrain neutrino mass
- Multi-wavelength
 - cosmology-specific needs, opportunities

Comments received from over 30 colleagues

Agenda for FNAL meeting:

- Discuss each bullet in charge (different moderator for each)
- Identify missing pieces (e.g. time-varying α as probe of quintessence)
- Identify people who will work on each aspect over the coming 10 months

CF6: Cosmic Particles and Spacetime Physics

Conveners: J. Beatty, A. Nelson, A. Olinto

Charge:

Survey and summarize current knowledge, and identify future opportunities in cosmic rays, cosmic neutrinos, baryogenesis, leptogenesis, Big Bang nucleosynthesis, supernova neutrinos, Lorentz invariance violation, tests of fundamental symmetries, cosmic signatures of exotic particles/hidden sectors, holographic noise

- Physics of Interactions beyond Laboratory Energies
- The Matter of the Cosmological Asymmetry
- Cosmic Particles as Probes of Fundamental Symmetries and New particles.
- Neutrino Physics from Astrophysics
- Exploring the basic nature of space and time

Plans through March: call for white papers

plans beyond March: prepare report for Snowmass 2013 –
present at APS meeting

Cosmic Frontier Friday Agenda

Cosmic Frontier (Curia II)

9:30 - 9:35 Introductions

9:35 - 9:55 DOE (10 min. presentation + 10 min questions)

9:55 - 10:15 NSF (10 min. presentation + 10 min questions)

10:15 - 11:45 Subgroup charge presentations and coordination of overlaps, discussion (10 + 5 per subgroup)

11:45 - 12:30 Lunch

12:30 - 13:15 Some subgroups meet with Instrumentation/Capabilities (Curia II)

Subgroup splinters:

CF1: Black Hole (WH2NW)

CF2: Theory (WH3NE)

CF3: One North (WH1NW)

CF5: Snake Pit (WH2NE)

CF6: Comitium (WH2SE)

13:15 - 14:00 Some subgroups meet with Computing (Curia II); other subgroups continue their splinter mtgs.

14:00 - 14:30 Break

14:30 - 15:30 Plenary session: 7 min reports from each subgroup on path forward; then, discussions of paths forward and main points for Cosmic Frontier summary talk on Saturday

Current Plan for Deliverables

- Continuously updated web pages
- A short (~15 page + 2 page executive summary) document on Dark Matter complementarity, primarily for use by government decision makers. Planning to have a draft of this document before the March workshop that can be sharpened during the workshop. Expect to have this widely circulated for comments and complete well before the summer meeting.
- After the summer meeting, each subgroup will produce a summary (~30 pages each) contribution. There will also be a short overall Cosmic Frontier summary. The combined ~200 page document will be posted to the arXiv.
 - Additional contributed papers and white papers are encouraged and will presumably be useful references for the ~200 page document.

Summary

- Off to a good start. Continuing to work to engage the broad community in CSS2013.
 - now spreading the word via the subgroups
 - suggestions welcome!
- Nexus of activity at the March Cosmic Frontier workshop
- Join the fun