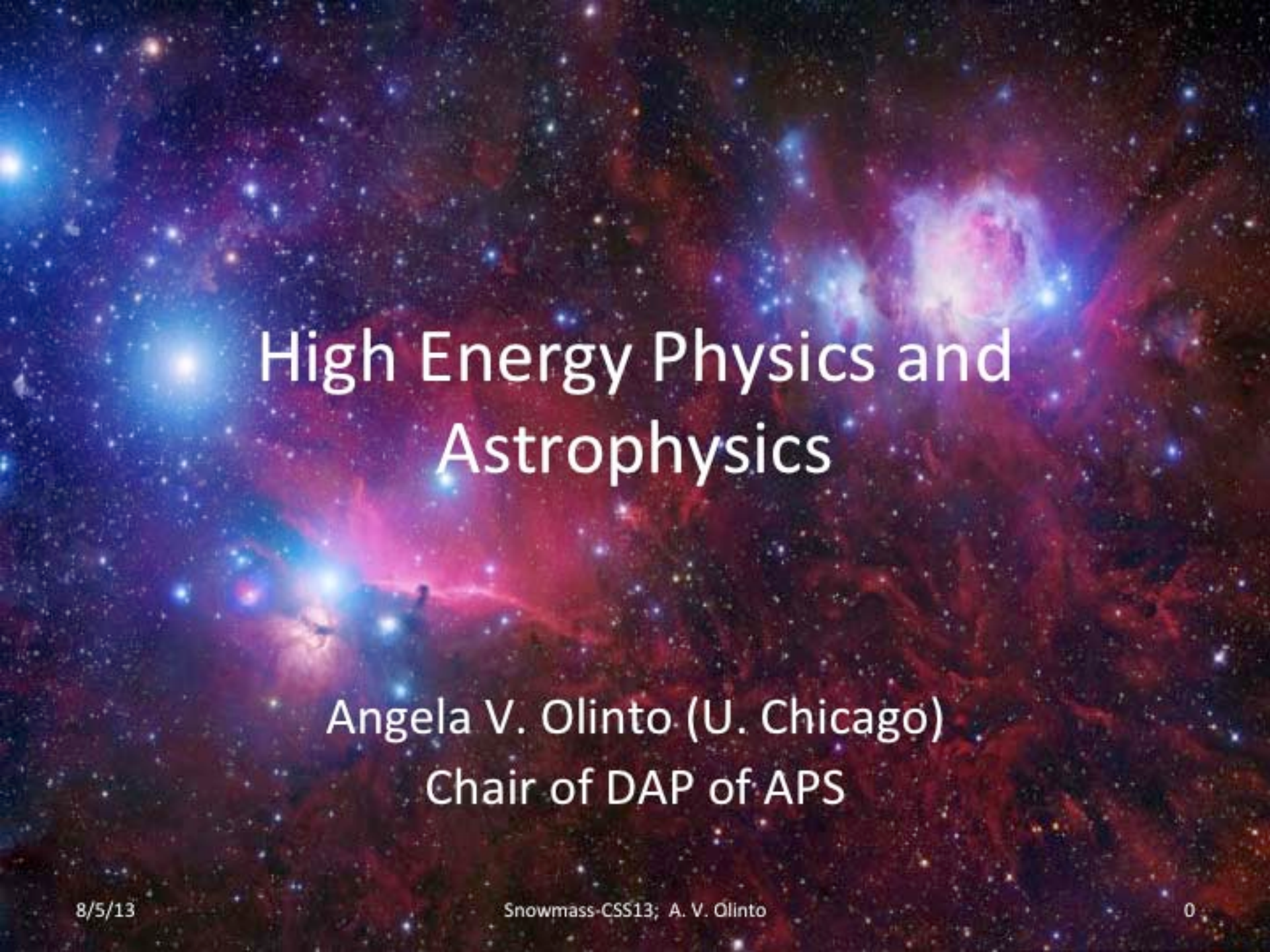


A vibrant cosmic background image featuring a dense field of stars, distant galaxies, and colorful nebulae in shades of blue, purple, and red. The text is overlaid on this celestial scene.

High Energy Physics and Astrophysics

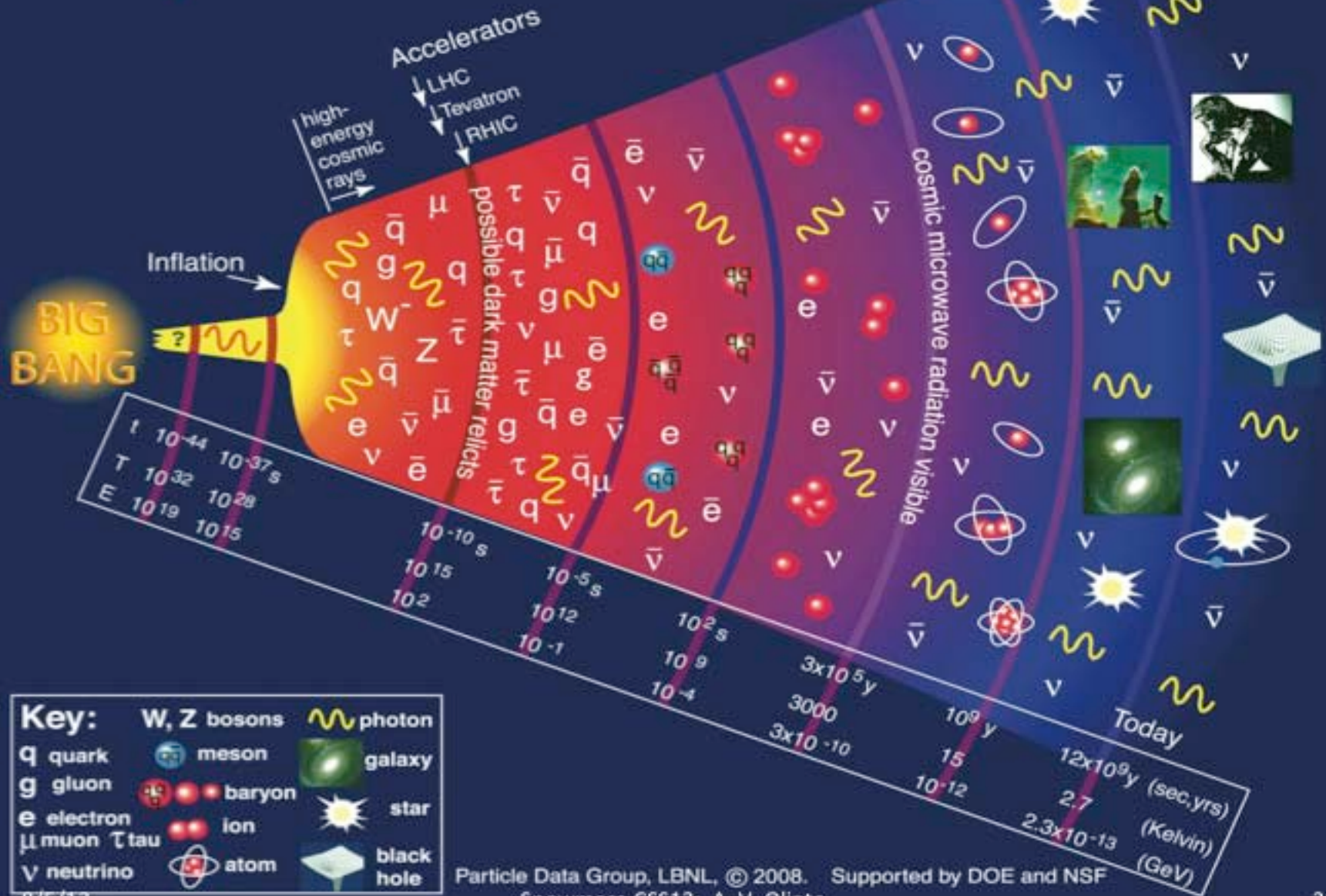
Angela V. Olinto (U. Chicago)
Chair of DAP of APS

APS Division of Astrophysics (DAP)

DAP strongly supports DPF's effort to organize the HEP community to identify:

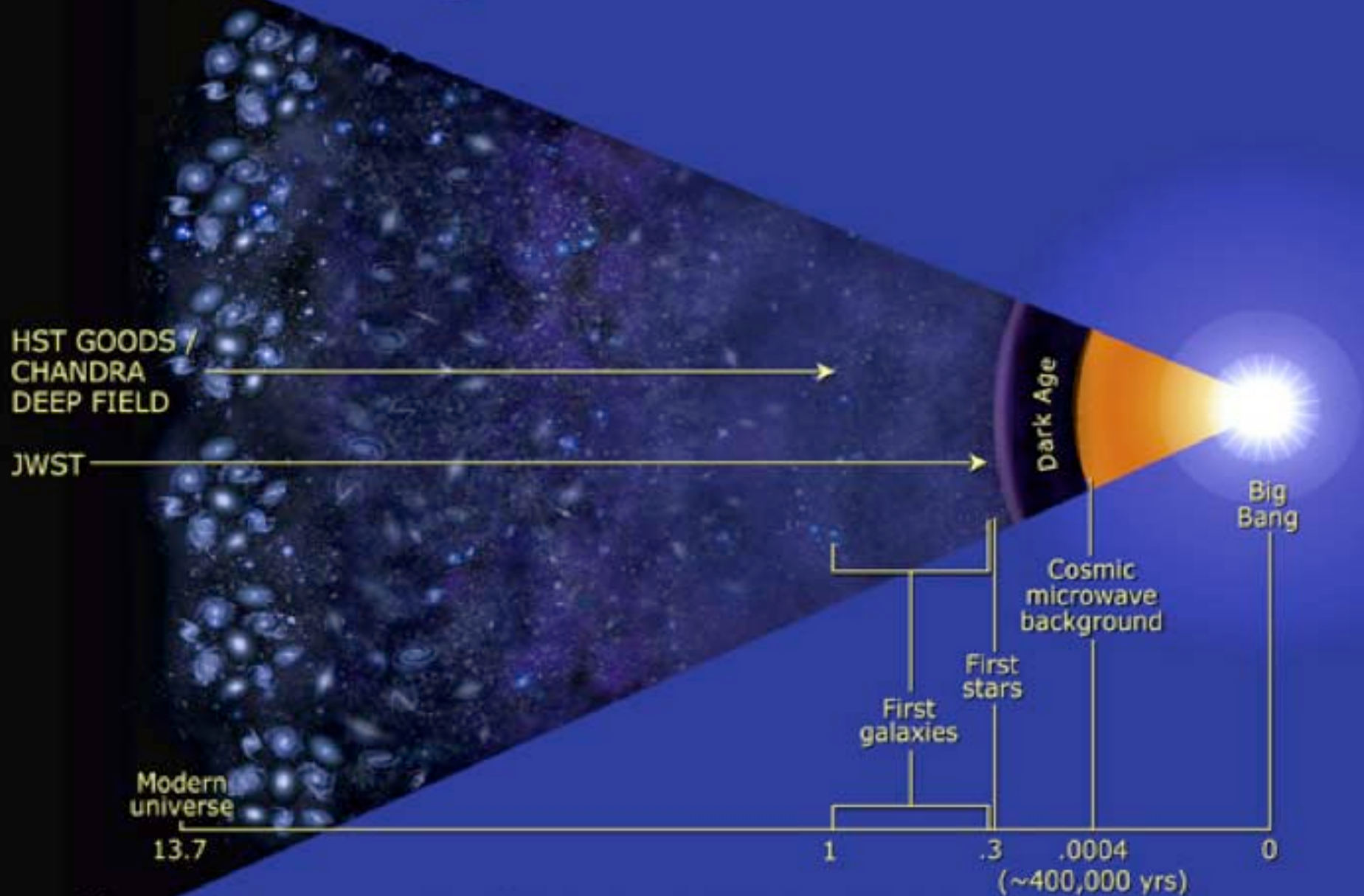
- the next exciting Particle Physics questions and
- the projects to answer them

History of the Universe



Particle Data Group, LBNL, © 2008. Supported by DOE and NSF
Snowmass-CSS13; A. V. Olinto

Seeing back into the cosmos





DAP members are diverse

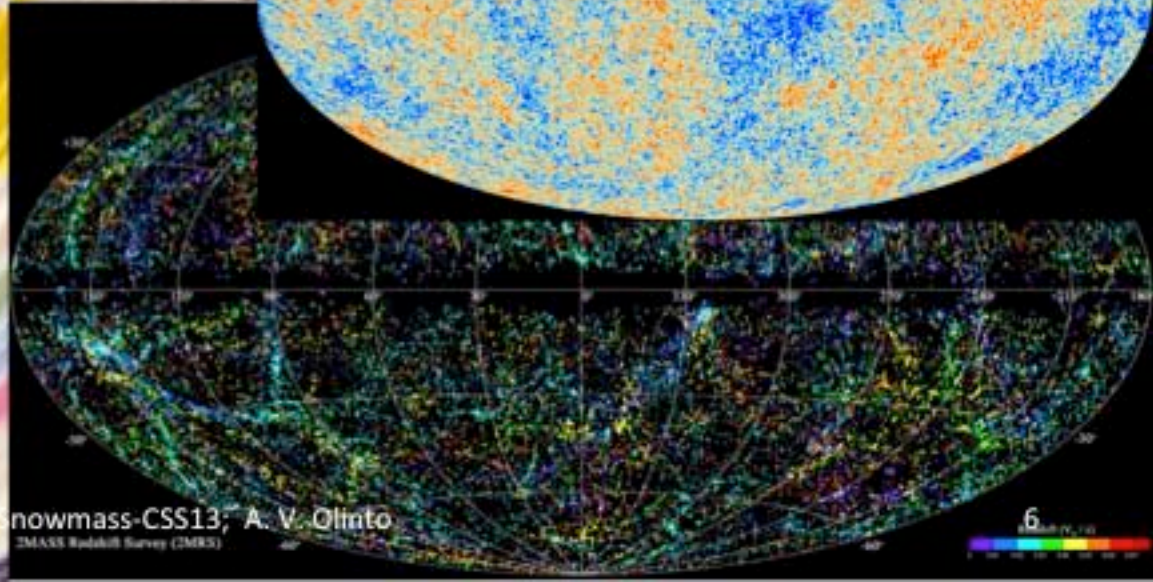
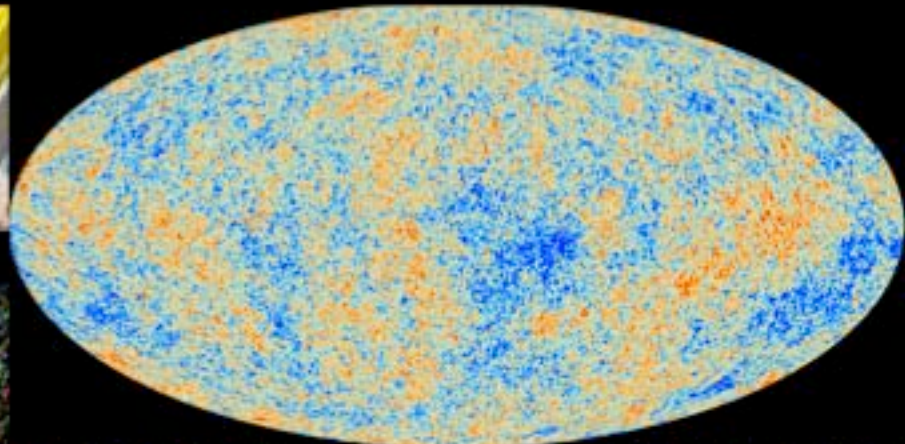


DAP members are diverse

joint with DPF, DNP, GGR,
DAMOP, DCOMP, DPP, ...

DAP members are diverse

From Solar System to the Universe

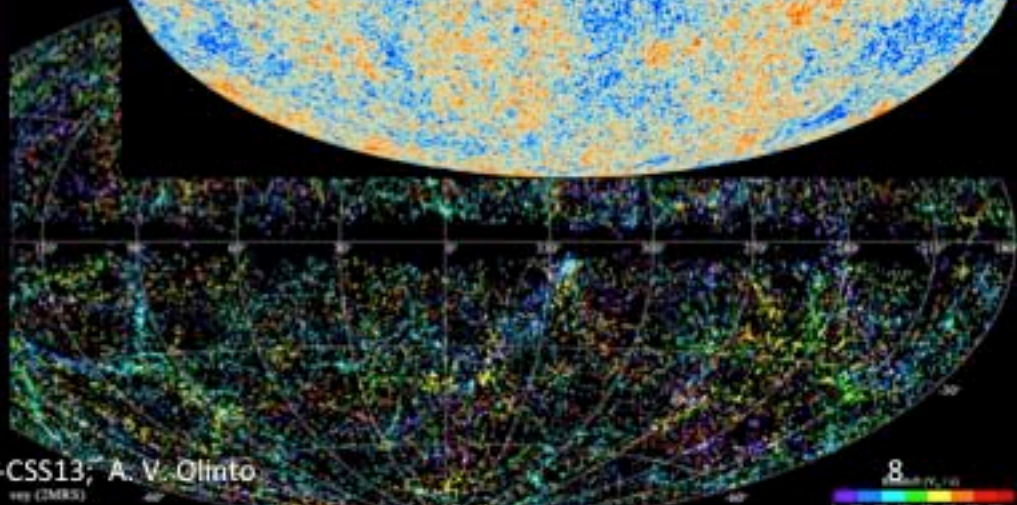
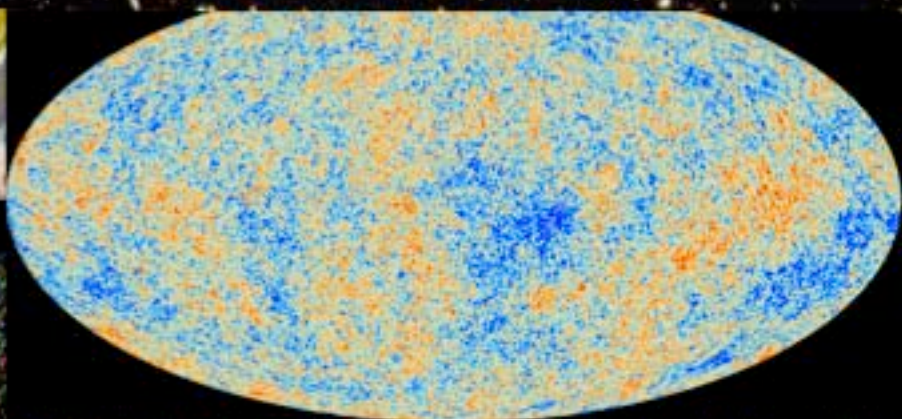


DAP members are diverse

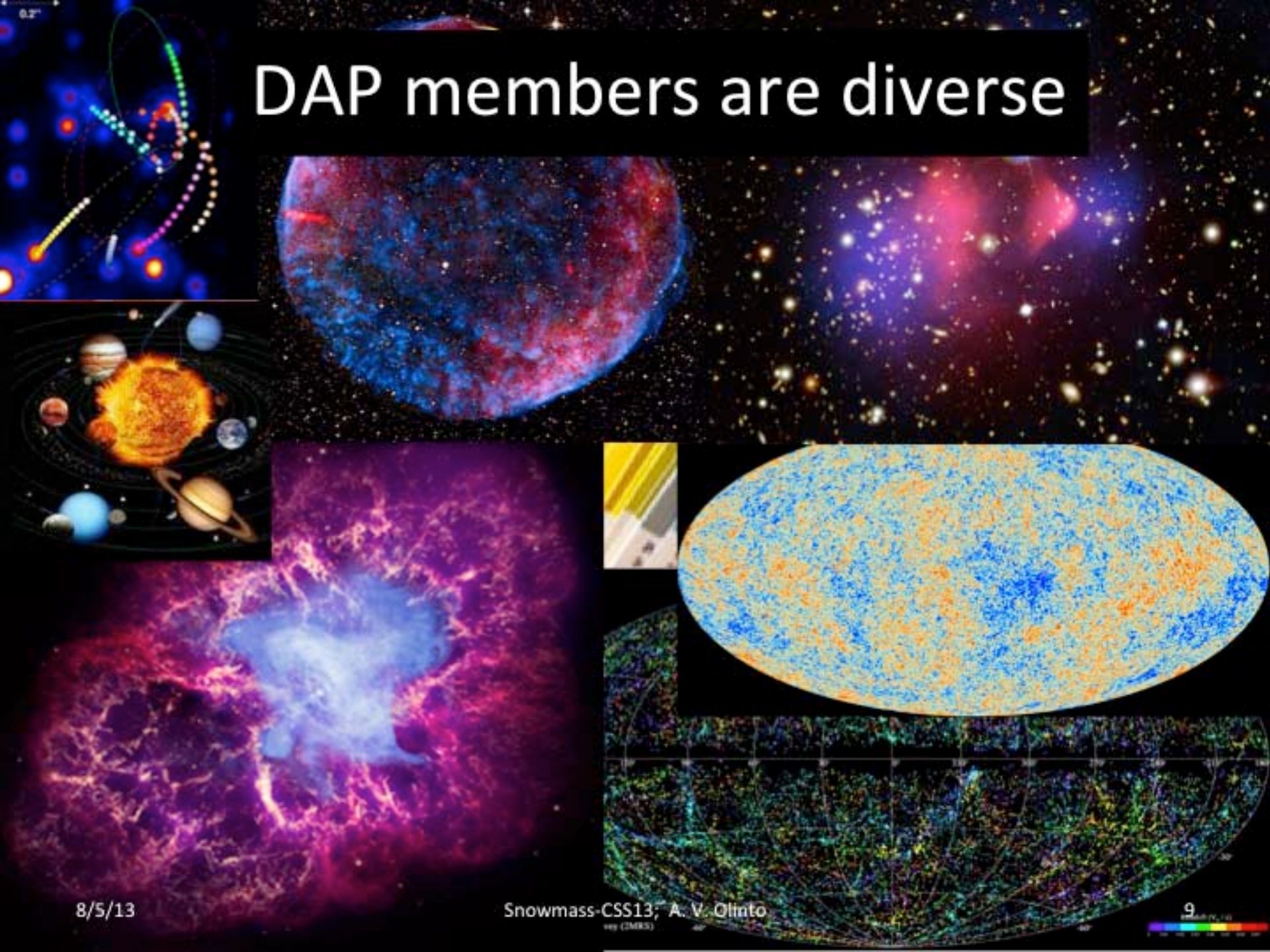
8/5/13

Snowmass-CSS13; A. V. Olinto

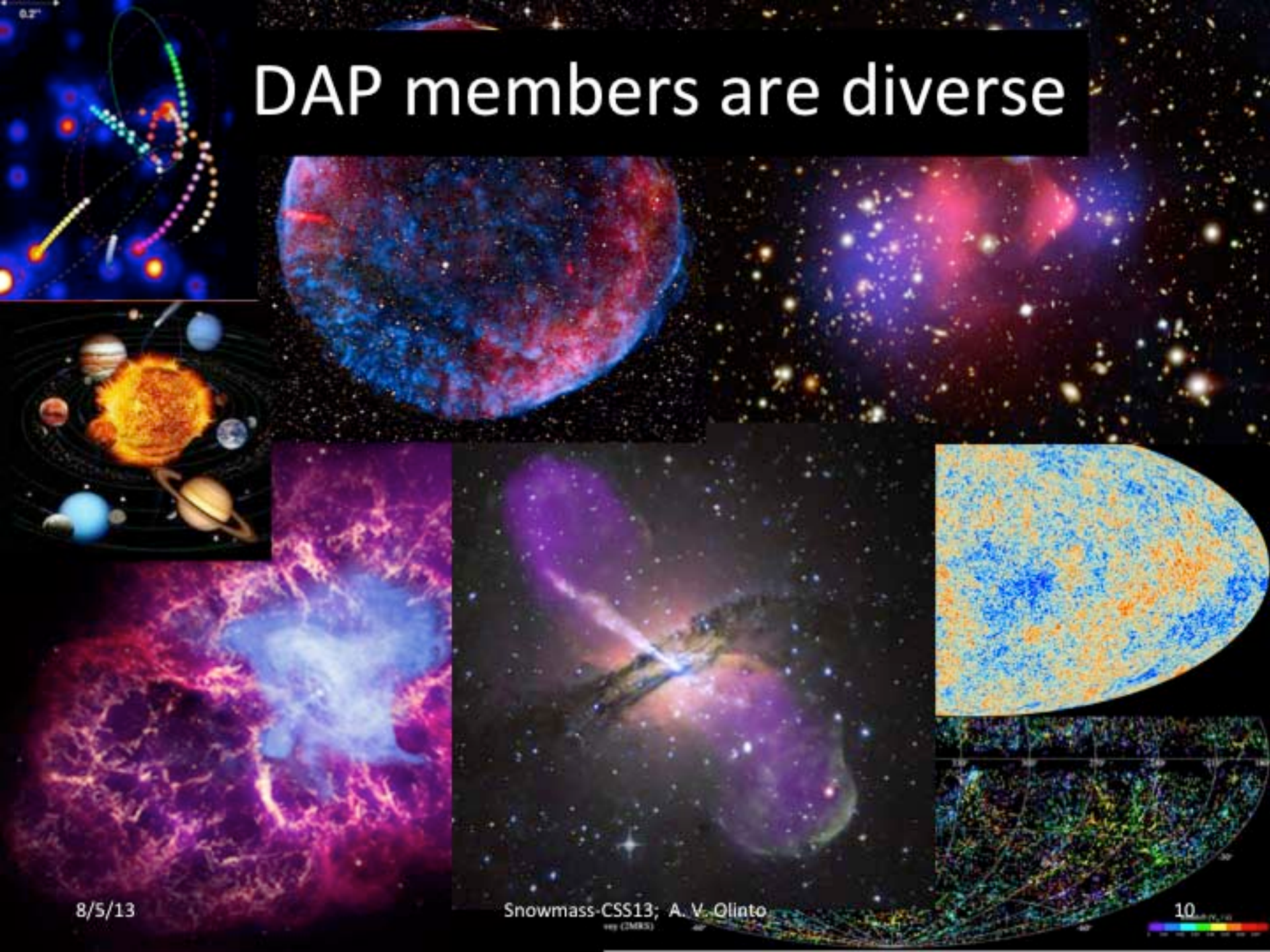
DAP members are diverse



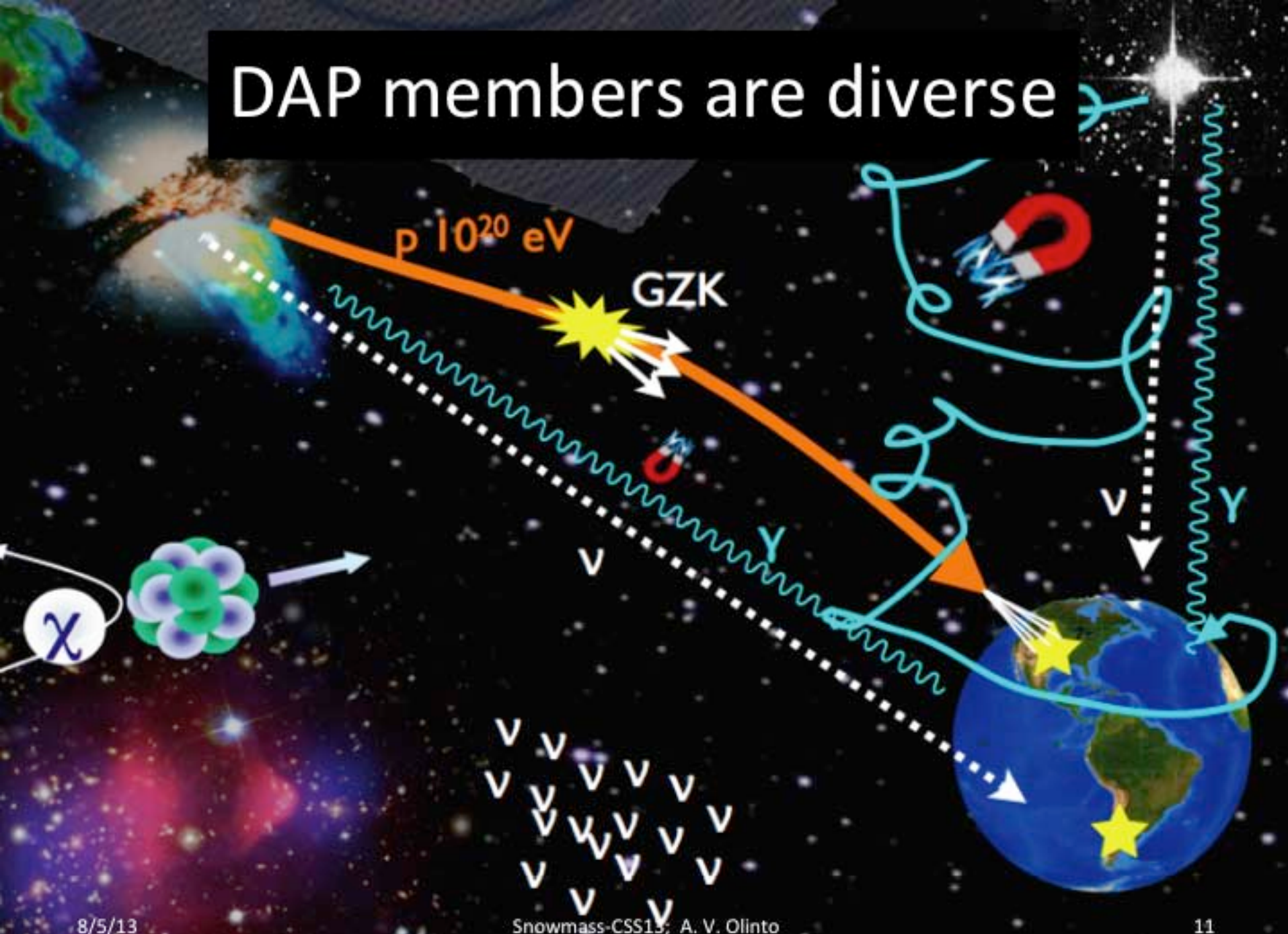
DAP members are diverse



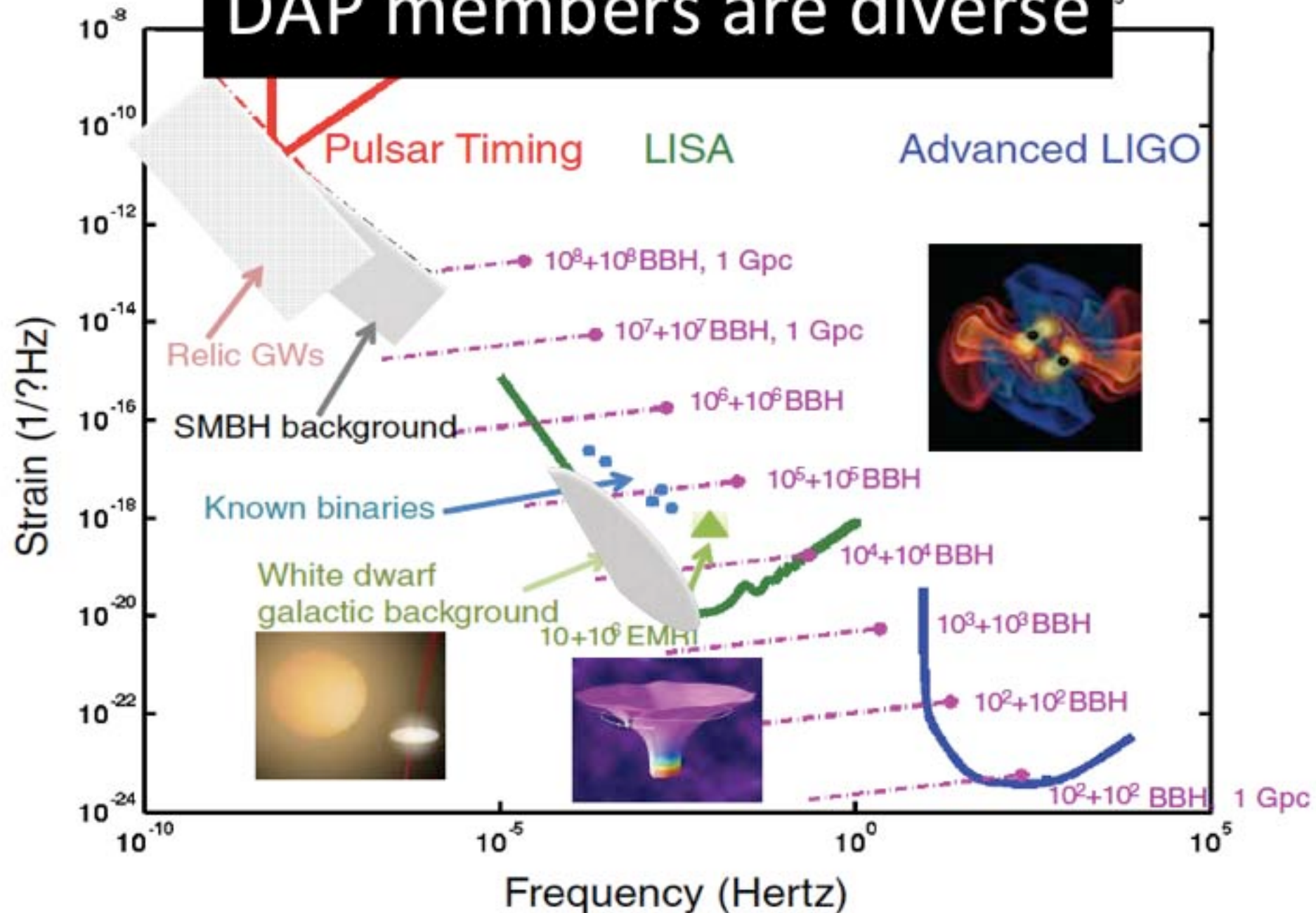
DAP members are diverse



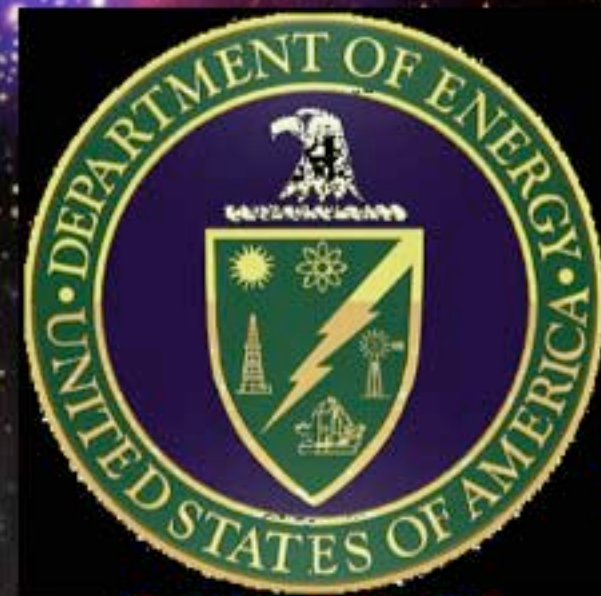
DAP members are diverse



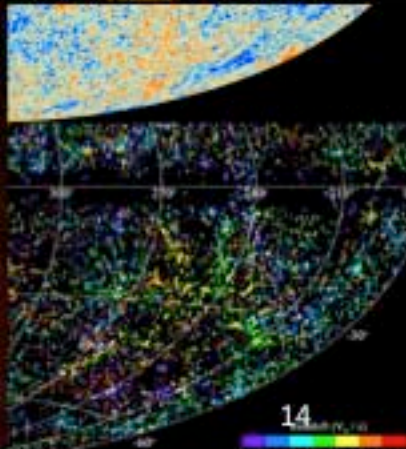
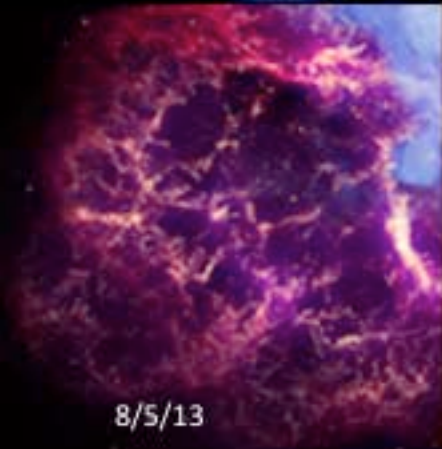
DAP members are diverse



DAP members are diverse



DAP members are diverse



Particle Physics and Astrophysics

Long History of overlap from the beginnings of Particle Physics

Birth of Particle (& Astroparticle) Physics

Cosmic Rays

1953

1932 Positron

1936 Muon

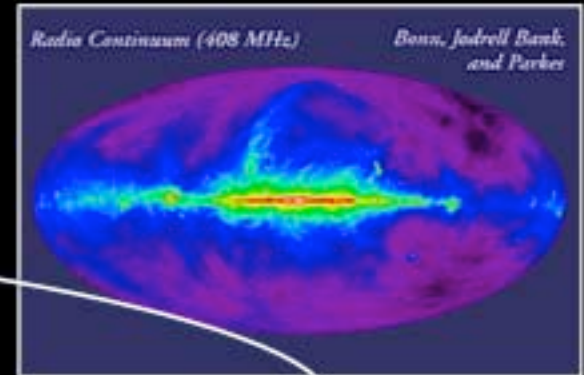
1947 Pions : π^0 , π^+ , π^-

1949 Kaons (K)

1949 Lambda (Λ)

1952 Cascade (Ξ)

1953 Sigma (Σ)



astrophysics



particle physics



CONGRÈS INTERNATIONAL SUR LE RAYONNEMENT COSMIQUE
BAGNÈRES-DE-BIGORRE, 6-12 Juillet 1953

Photo AUX



Louis Leprince-Ringuet

The congress of Bagnères de Bigorre sounded the death knell for cosmic rays and it was Powell himself who in his closing discourse had said "Gentleman, now we are invaded, we are submerged, these are the accelerators"

L. Leprince-Ringuet

J de Physique (Colloque #8) V 43 (1982)

38

Au Pic du Midi c'était Ch. Peyrou, B. Grégory, A. Lagarrigue, R. Armenteros, F. Muller puis A. Astier. Ont participé non seulement les français mais aussi des étrangers comme Ronald Rao de Princeton, Tinlot de Rochester, Destaeble de Mit et aussi B. Le Fretter, en partie. Vous savez ce qui a été étudié au Pic.

Le congrès de Bagnères de Bigorre en 1953, je dirais, a sonné le glas des rayons cosmiques et c'est Powell lui-même qui, dans son discours de clôture a dit : "Messieurs, maintenant nous sommes envahis, nous sommes submergés, ce sont les accélérateurs". Effectivement, la plupart des laboratoires de rayons cosmiques dont le nôtre, ici à l'Ecole Polytechnique, puis au Collège de France, se sont orientés vers les grands accélérateurs de particules et je voudrais vous dire aussi que le mot hypéron a été annoncé pour la première fois au congrès de Bagnères. Il y avait B. Rossi, E. Amaldi, C. Powell. Et on s'est demandé comment appeler ces nouvelles particules qui s'arrêtaient, qui étaient lourdes et qui donnaient un méson. Alors on a proposé divers noms. Et je dois dire que c'est ma principale contribution à la physique, j'ai prononcé le mot hypéron : le mot hypéron n'a pas été bien accueilli par Rossi. Rossi a dit "oh, hypéron, piperone, ça va pas". Et au contraire Powell était là et a dit "oh hypéron (prononcer haiperon) marvelous". Et on a adopté le mot hypéron. Et il a à Bagnères de Bigorre l'avenue de l'hypéron : c'est peut être le seul endroit au monde où une particule fondamentale a donné un nom à une avenue.



Standard Model

QUARKS	mass → 2.4 MeV/c² charge → 2/3 spin → 1/2  up	1.27 GeV/c² 2/3 1/2  charm	171.2 GeV/c² 2/3 1/2  top	0 0 1  photon	≈126 GeV/c² 0 0  Higgs boson	
	4.8 MeV/c² -1/3 1/2  down	104 MeV/c² -1/3 1/2  strange	4.2 GeV/c² -1/3 1/2  bottom	0 0 1  gluon		
	LEPTONS	0.511 MeV/c² -1 1/2  electron	105.7 MeV/c² -1 1/2  muon	1.777 GeV/c² -1 1/2  tau	91.2 GeV/c² 0 1  Z boson	GAUGE BOSONS
		<2.2 eV/c² 0 1/2  electron neutrino	<0.17 MeV/c² 0 1/2  muon neutrino	<15.5 MeV/c² 0 1/2  tau neutrino	80.4 GeV/c² ±1 1  W boson	

CONGRATULATIONS!!!



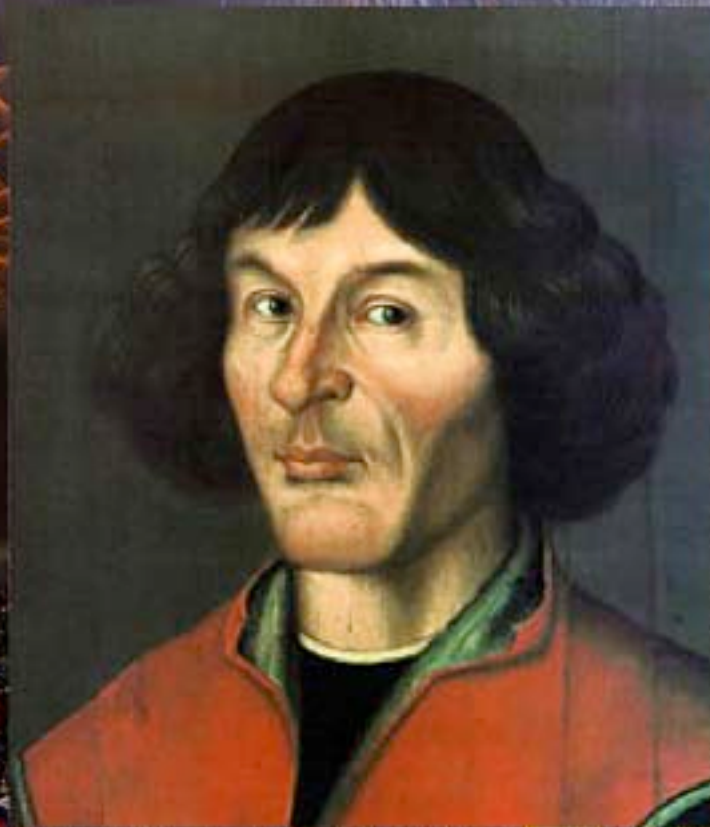
CONGRATULATIONS!!!

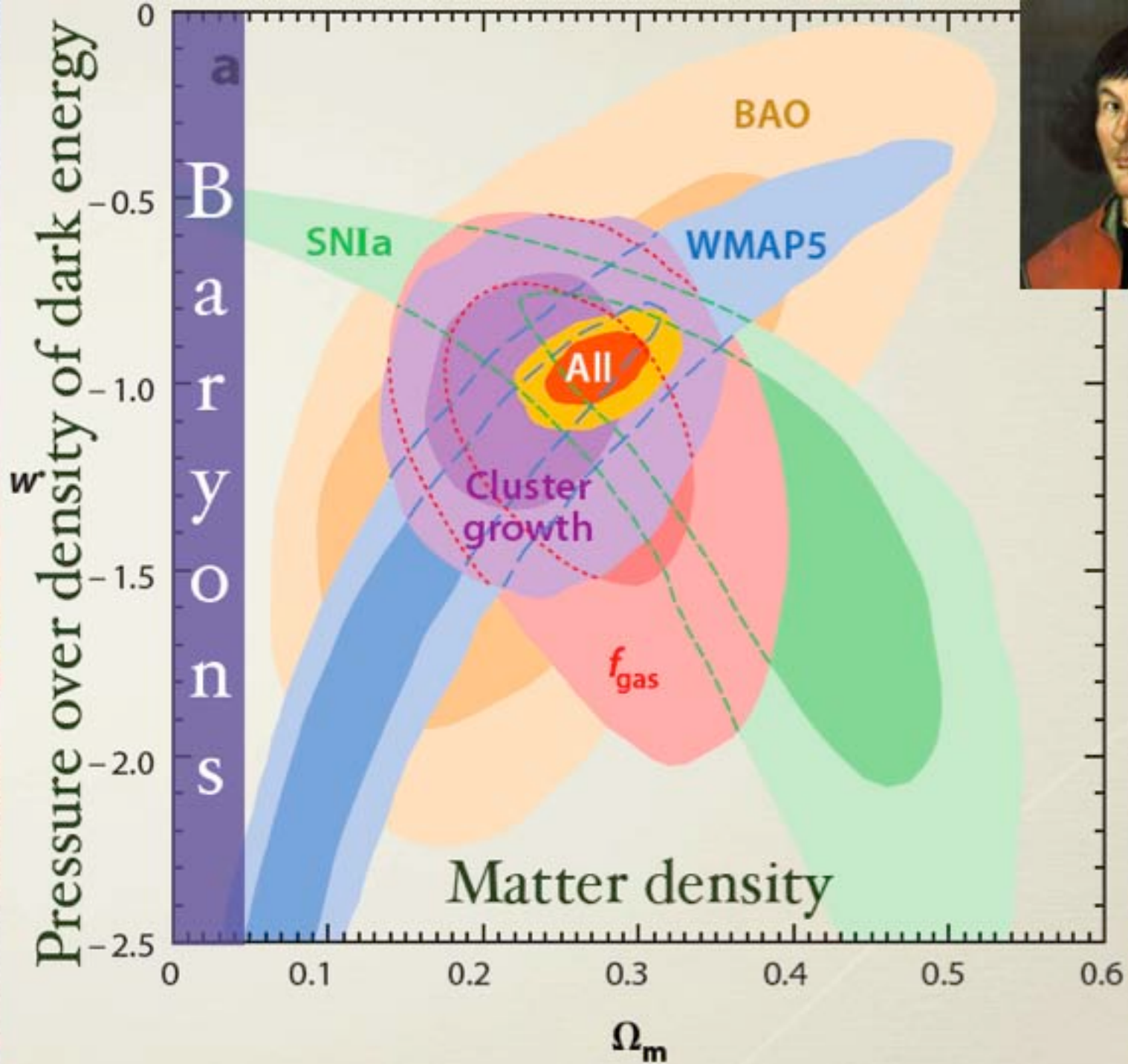
But...



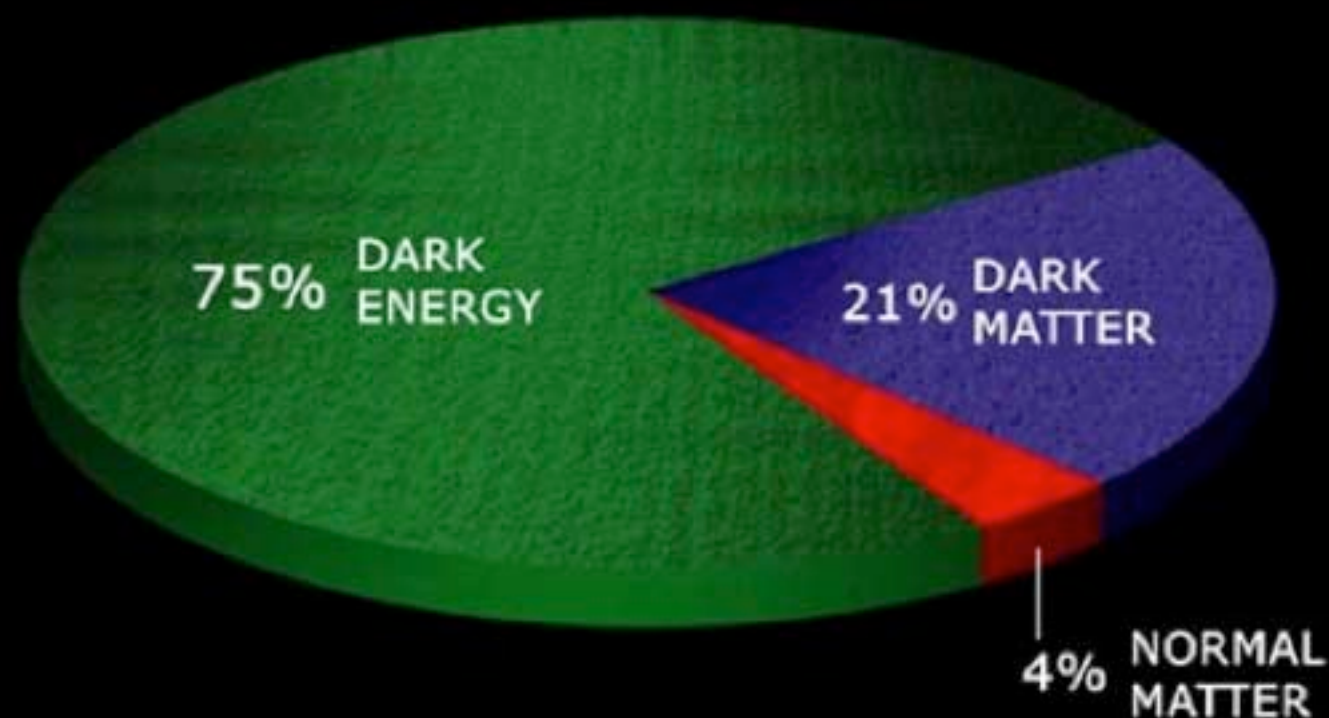
CONGRATULATIONS!!!

Copernican Revolution

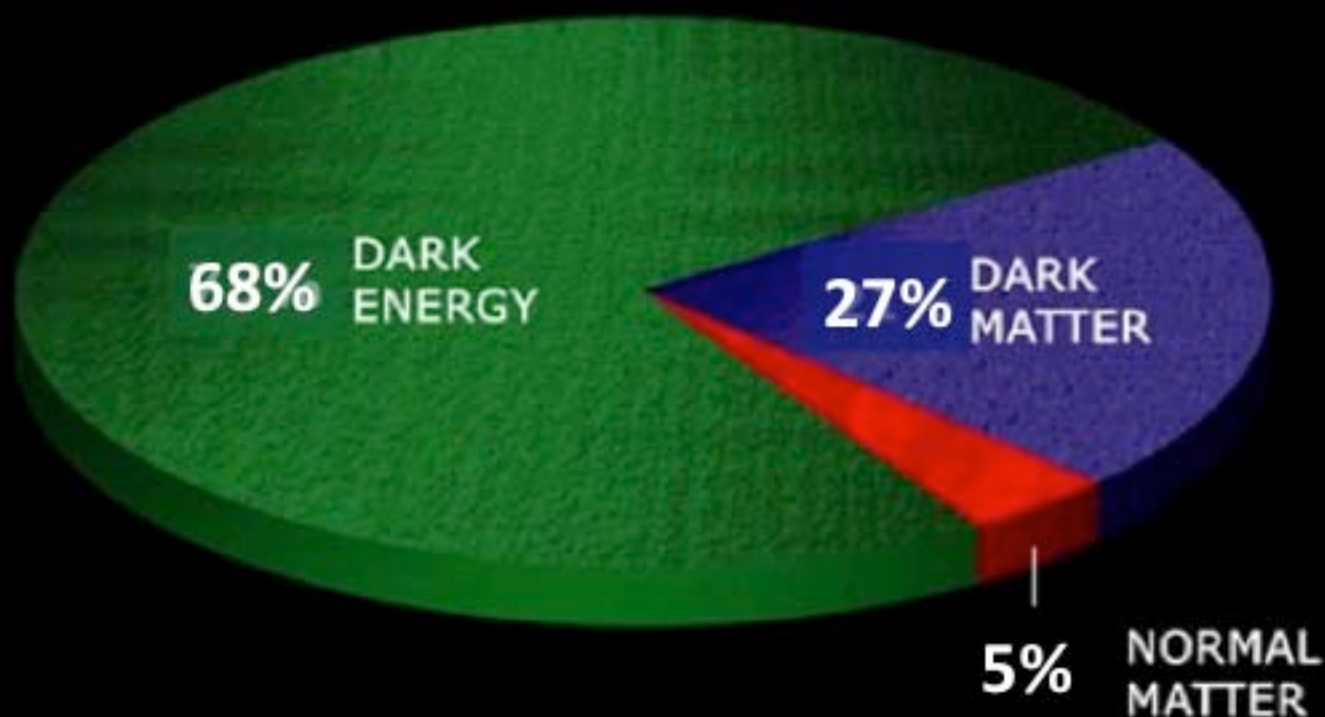
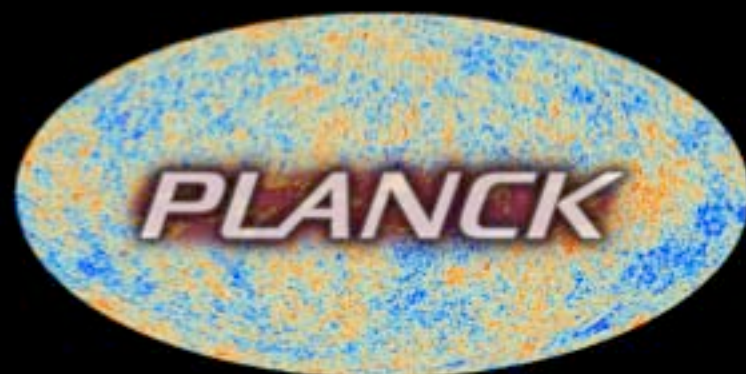




DARK MATTER & DARK ENERGY



DARK MATTER & DARK ENERGY



Particle Physics and Astrophysics

Evidence for New Physics from the Cosmos:

SOLAR NEUTRINOS

ATMOSPHERIC NEUTRINOS

Neutrino
Oscillations

DARK MATTER

???

DARK ENERGY

????

Particle Physics and Astrophysics

Long History of overlap from the beginnings of Particle Physics

Evidence for New Physics from the Cosmos

Great success of recent joint ventures

Physics Nobel Prize 2011



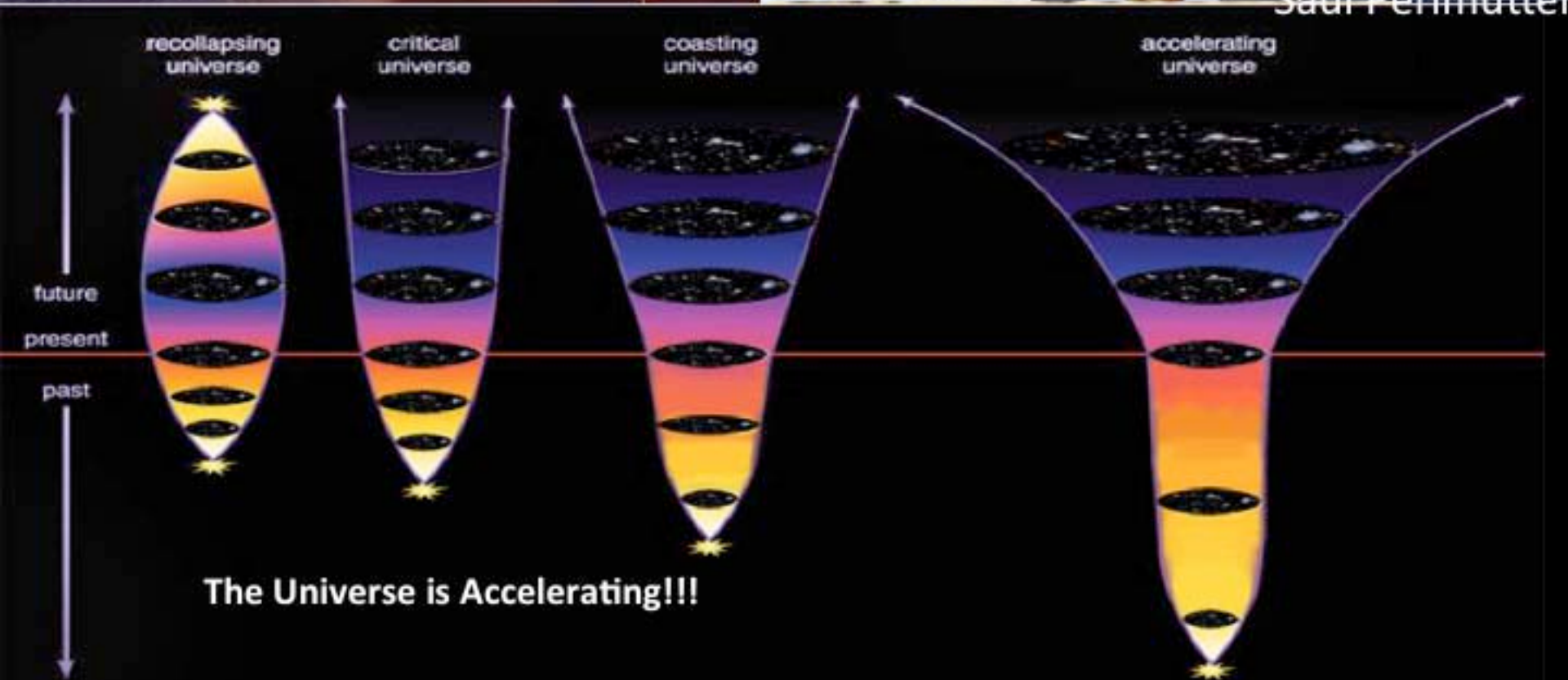
Adam G. Riess



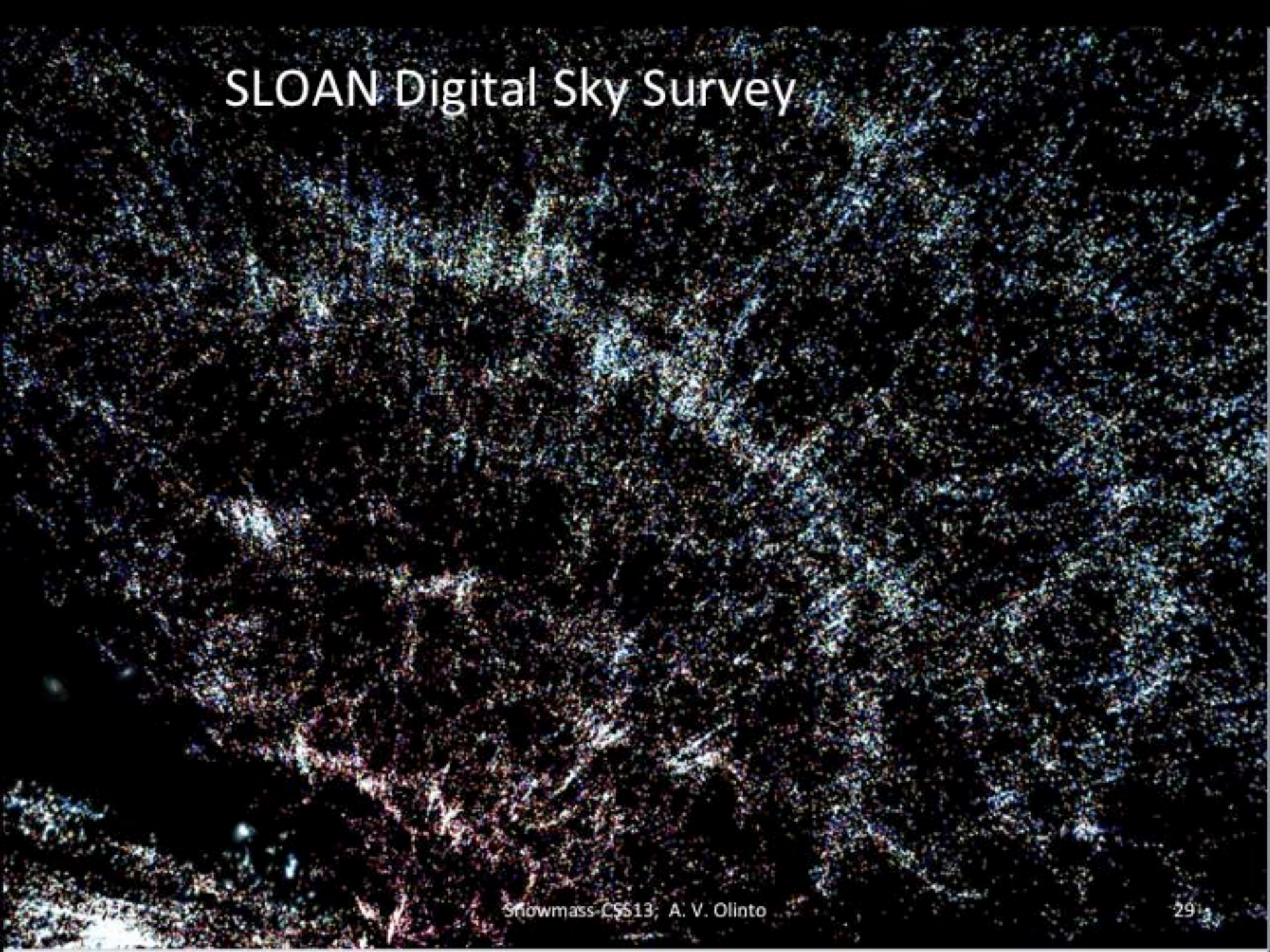
Brian P. Schmidt



Saul Perlmutter

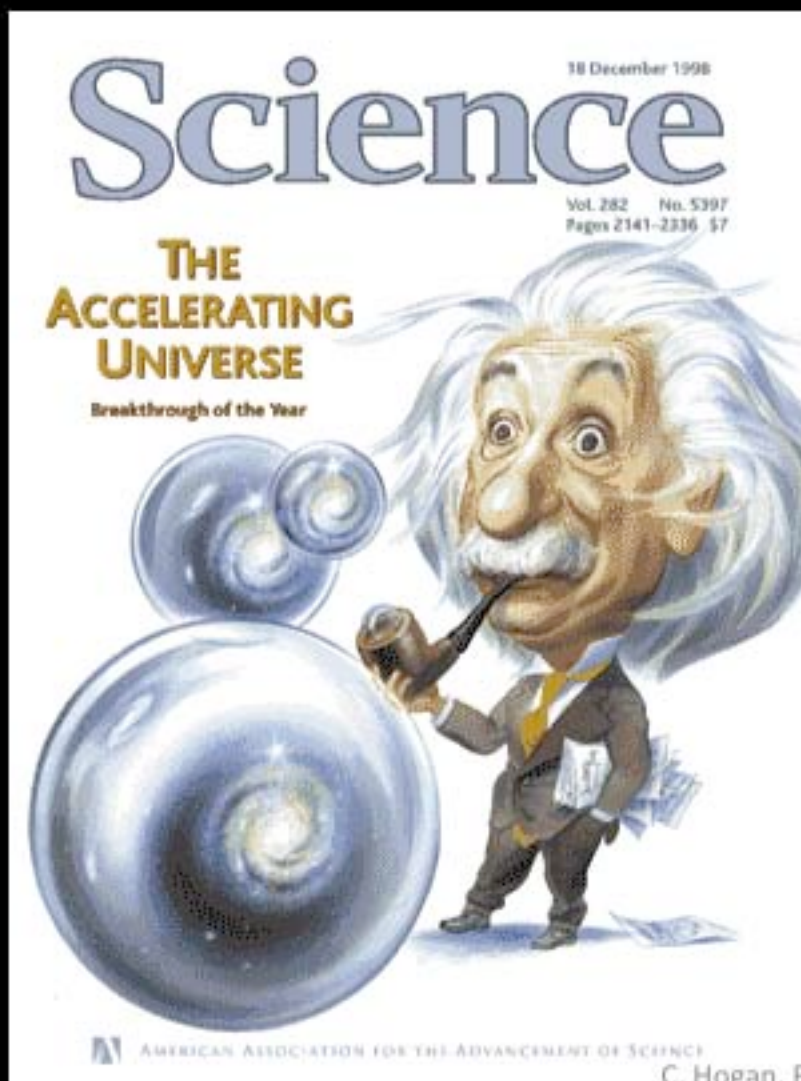


SLOAN Digital Sky Survey

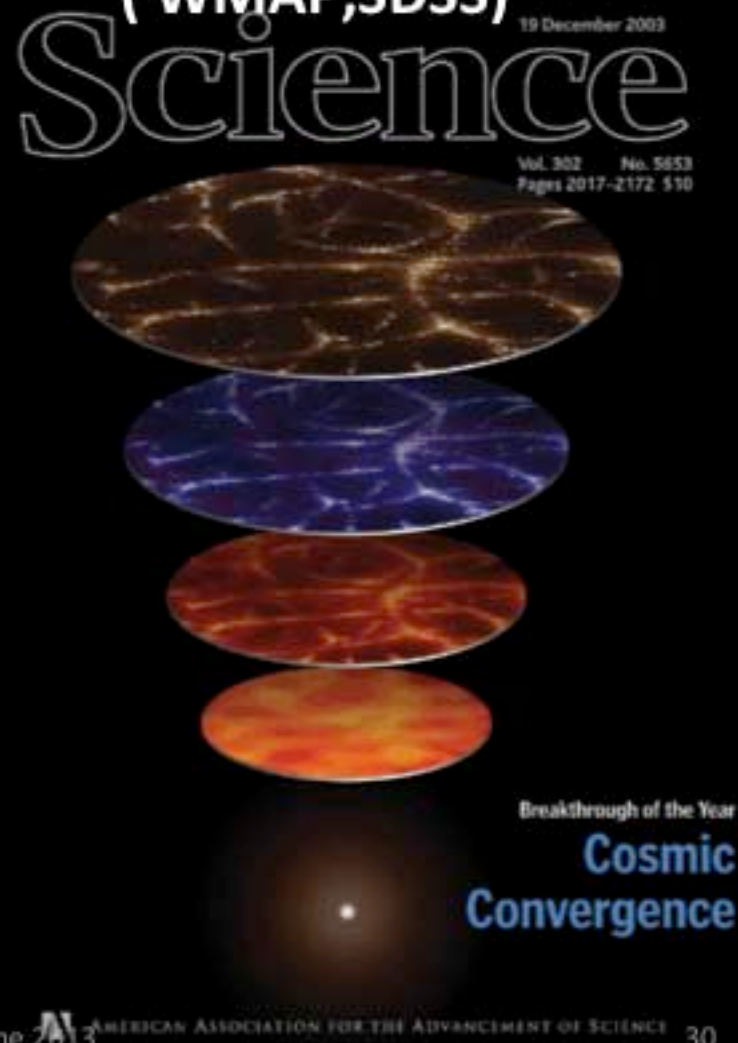


Science Breakthroughs of the Year

1998: Cosmic Acceleration



2003: Precision Cosmology (WMAP,SDSS)



Particle Physics and Astrophysics

Long History of overlap from the beginnings of Particle Physics

Evidence for New Physics from the Cosmos

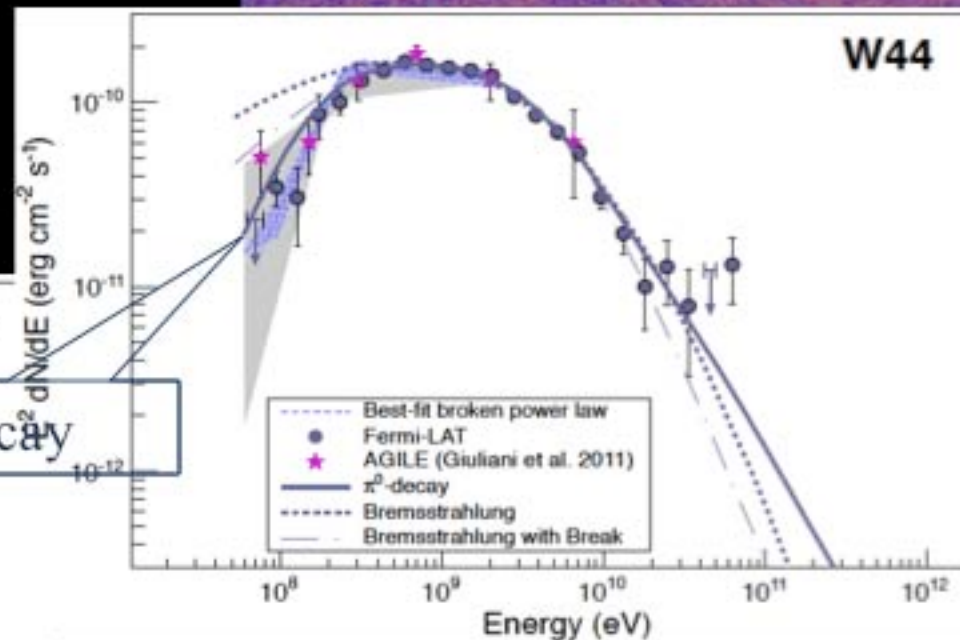
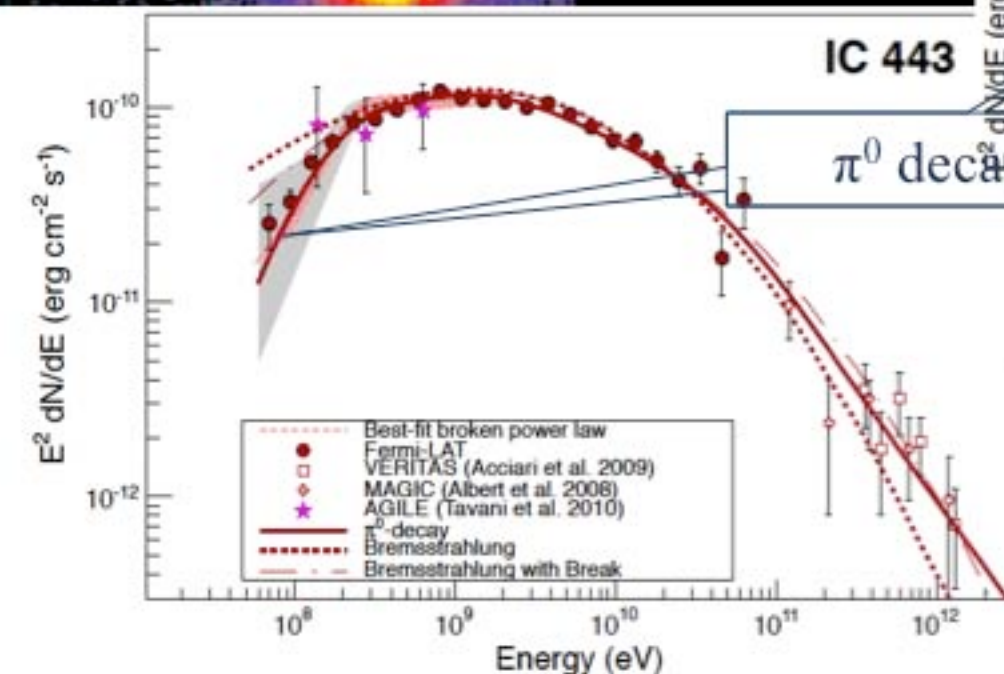
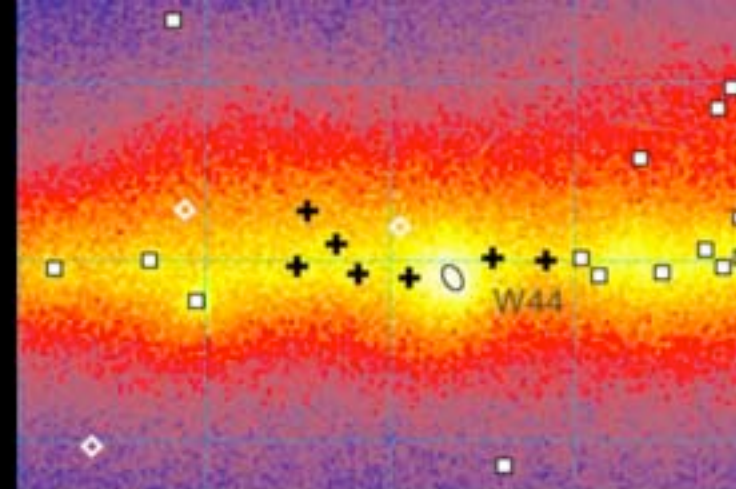
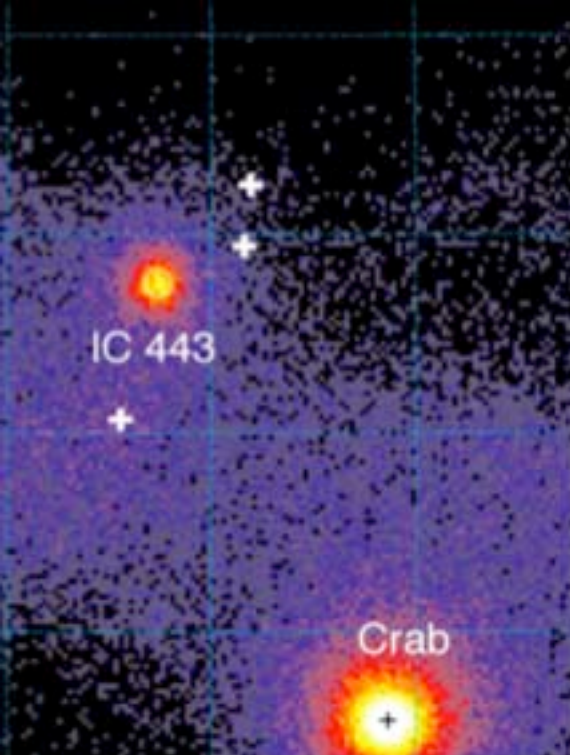
Great success of recent joint ventures

2013: A few Results in the interface

π^0 decay!

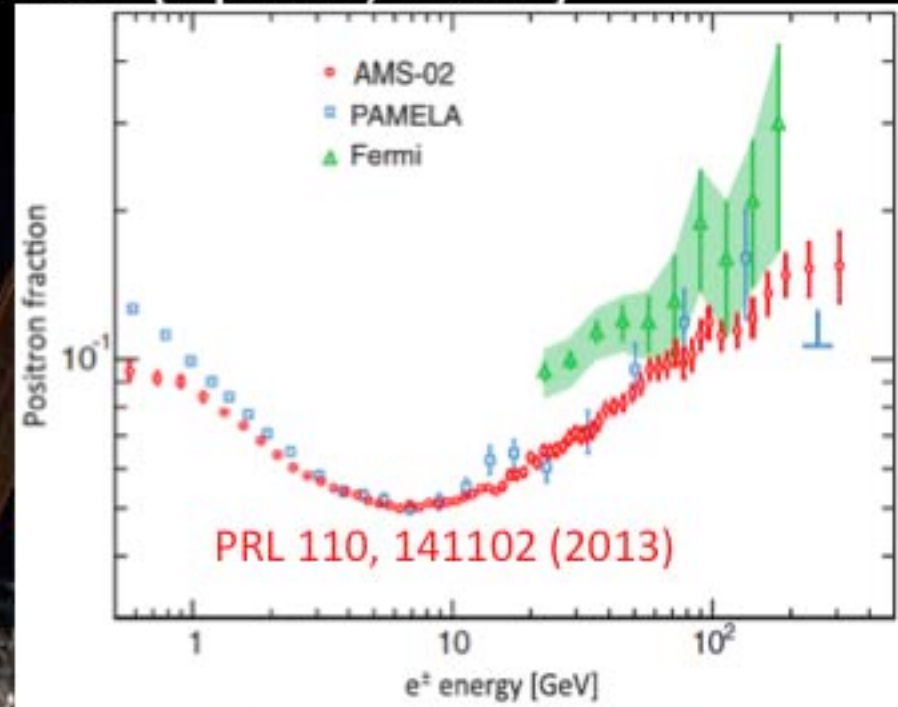
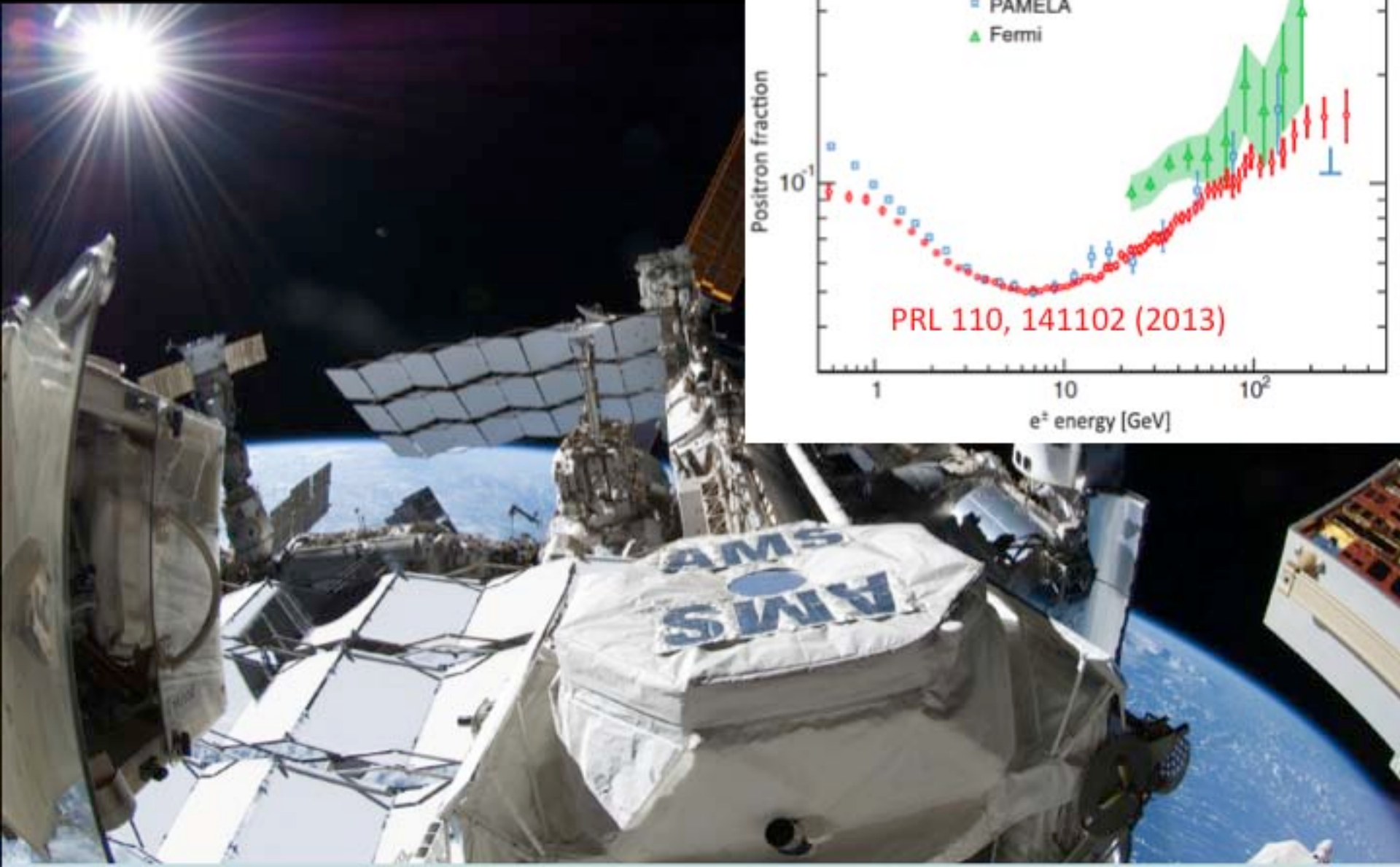
IC 443 & W44

Fermi & AGILE



Ackermann et al (Fermi Collab) '13

AMS first results (April 3, 2013)



Neutrino Astronomy Begins

PeV neutrinos first observed by IceCube (Apr'13)

Tue Aug 9 07:23:18 2011

Bert 1.05 PeV

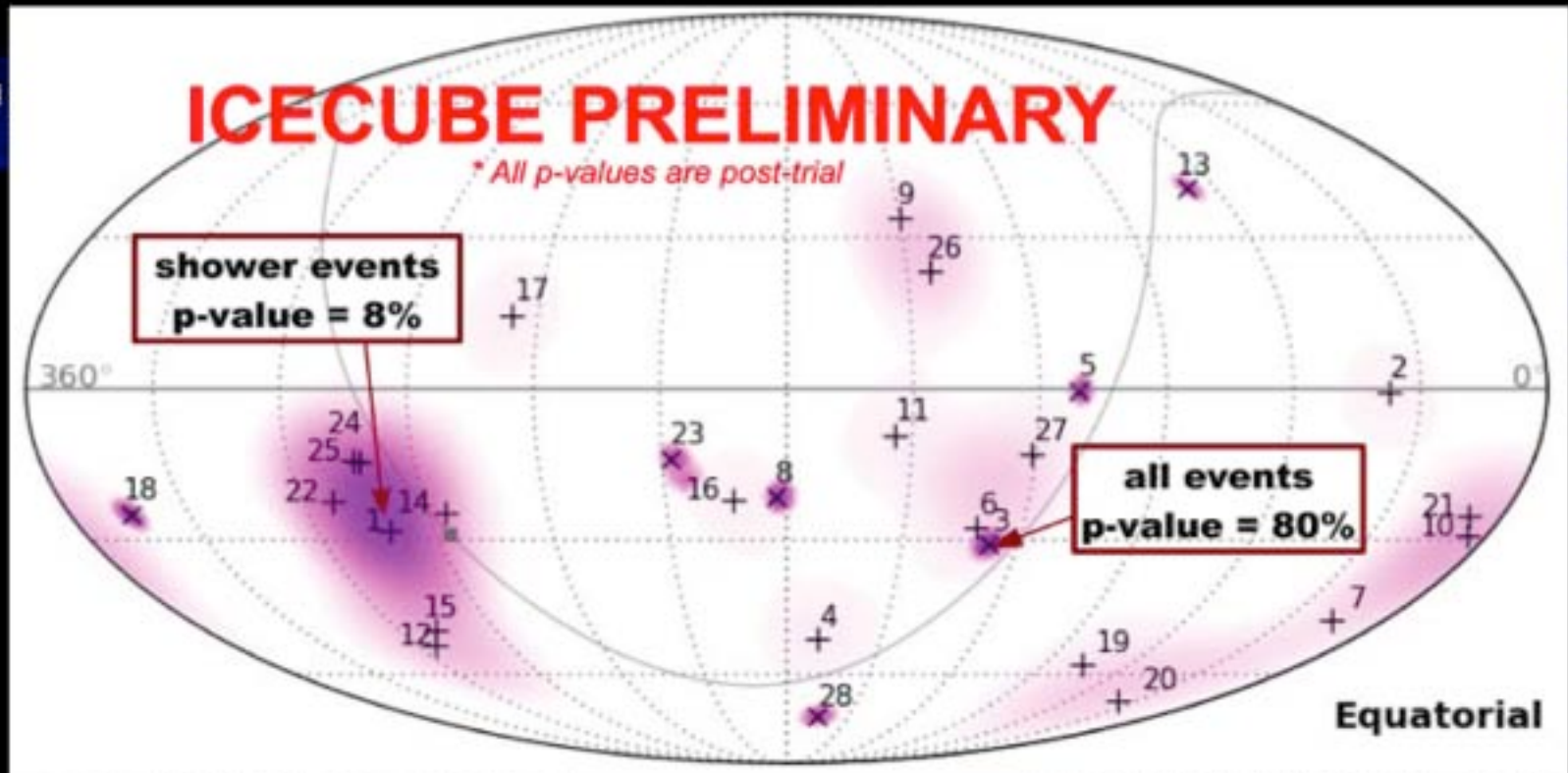
Tue Jan 3 03:34:01 2012

Ernie 1.15 PeV

Neutrino Astronomy Begins

PeV neutrinos first observed by IceCube (Apr'13)

Tue Aug



Particle Physics and Astrophysics

SIMILARITIES – need for

LARGE INTERNATIONAL PROJECTS/FACILITIES

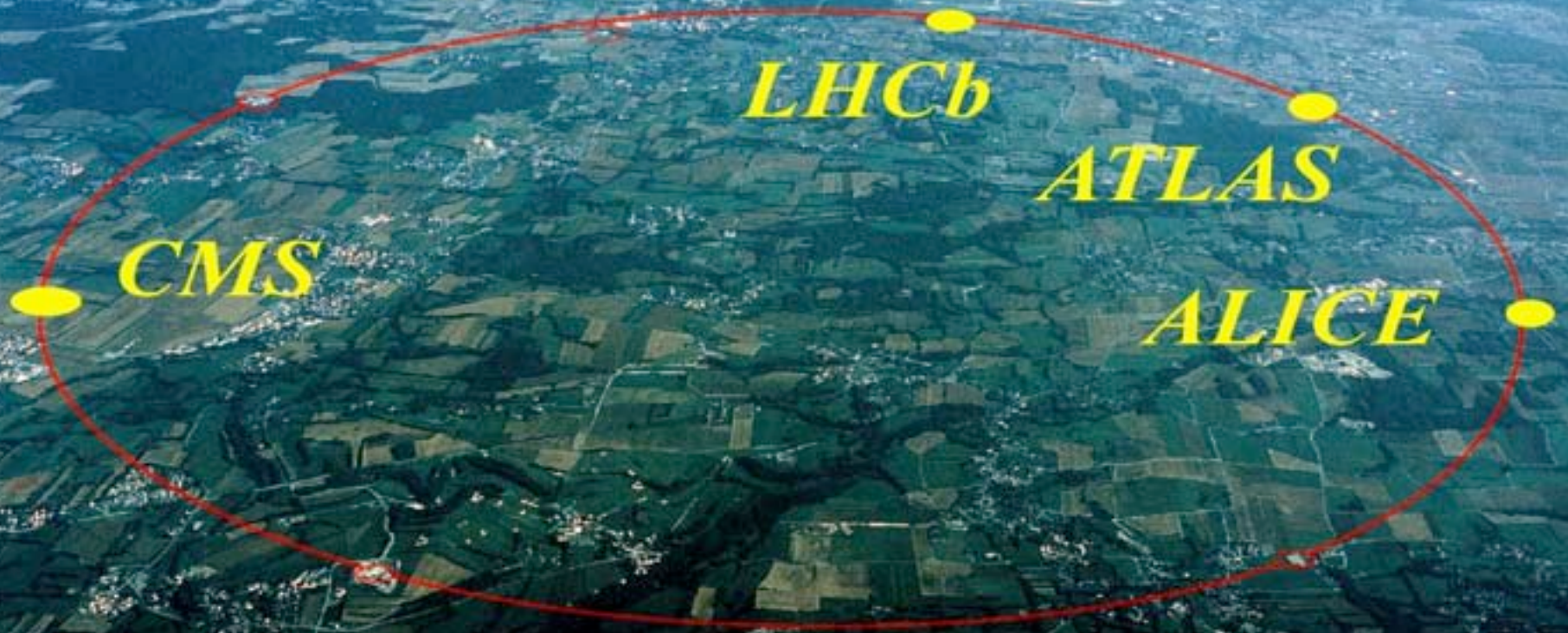
NEW DETECTOR TECHNOLOGIES

LARGE COMPUTATION EFFORTS

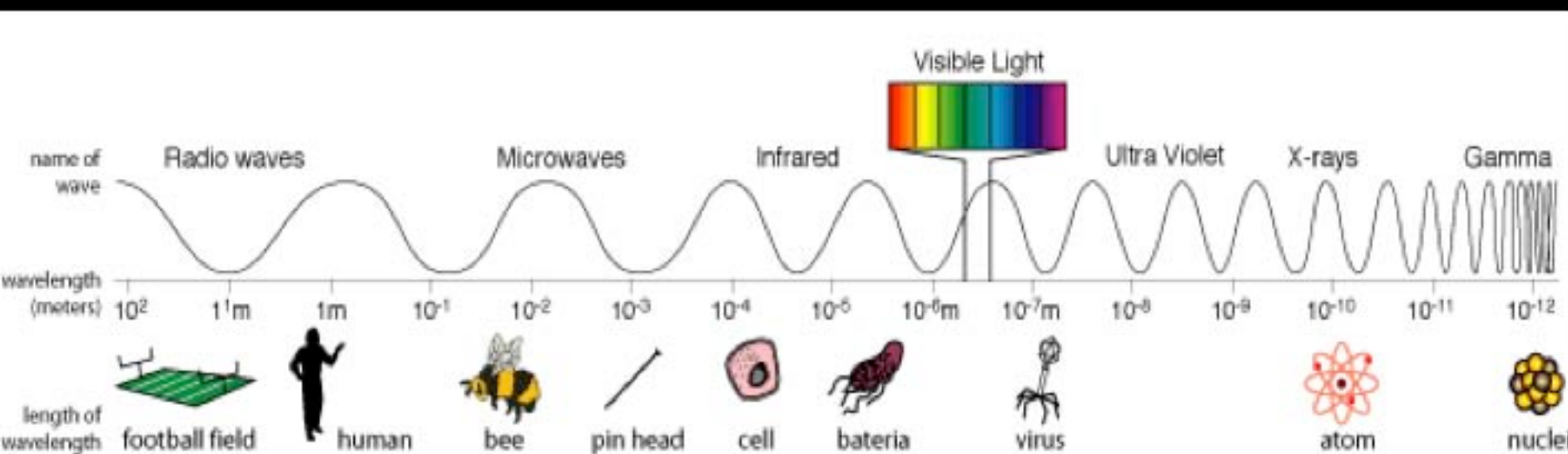
THEORY: NEW IDEAS & GUIDANCE

MontBlanc

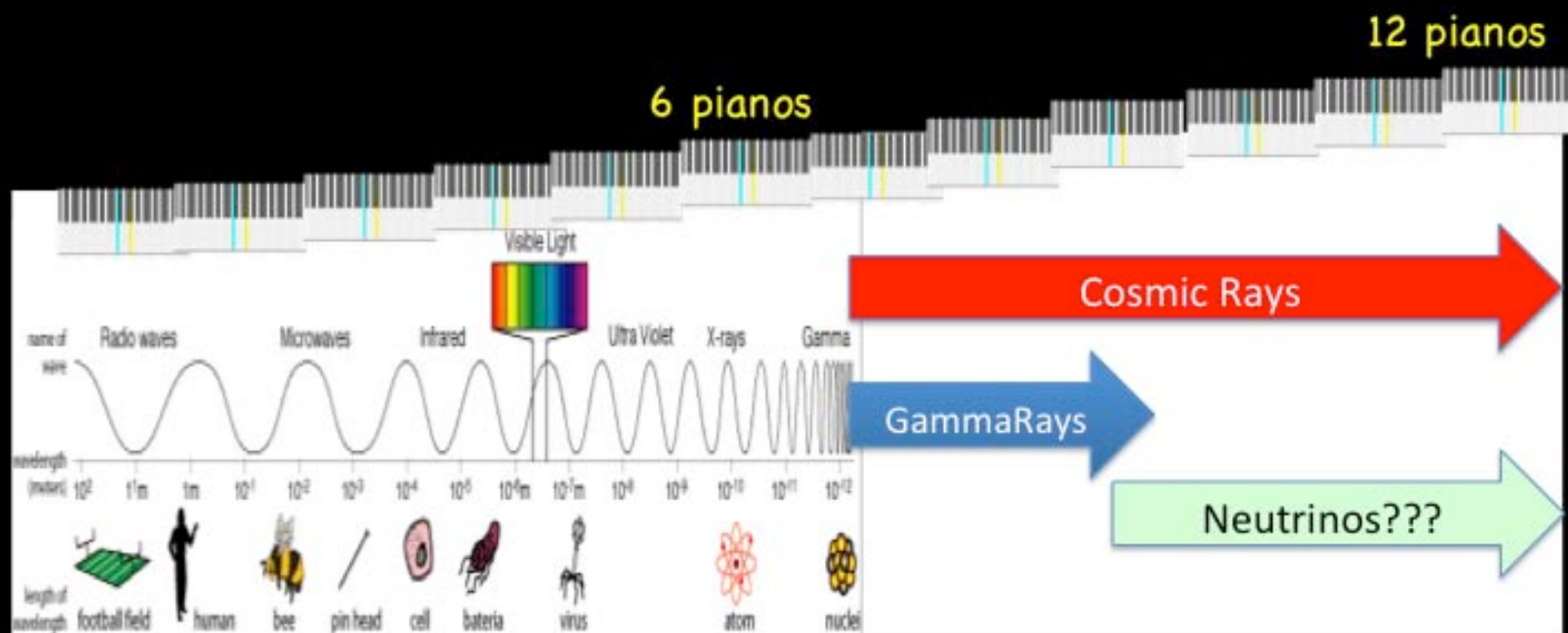
Large Hadron Collider @ CERN



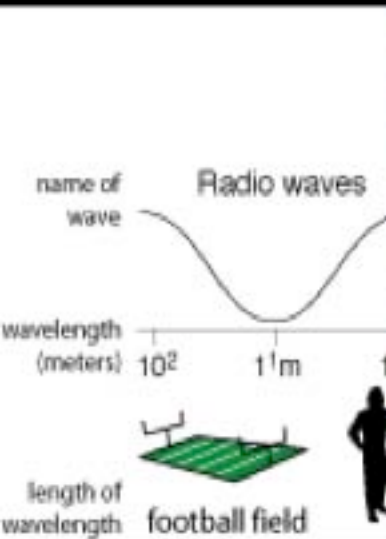
Tools Cover Wide Range



Tools Cover Wide Range



Radio Facilities



Optical/IR



HUBBLE space Telescope

Magellan Telescopes – Las Campanas (Chile)



LBT (Arizona)

Keck Telescopes – Mauna Kea (Hawaii)



Extreme Sites!!!



The Great Voyage

1977 to now and onwards...

Bow Shock?

Voyager 1

Voyager 2

Heliosheath
Termination Shock

Sun

Heliopause

Voyager 1 and 2 in 2012 Voyager
'leave' the Heliosphere in the

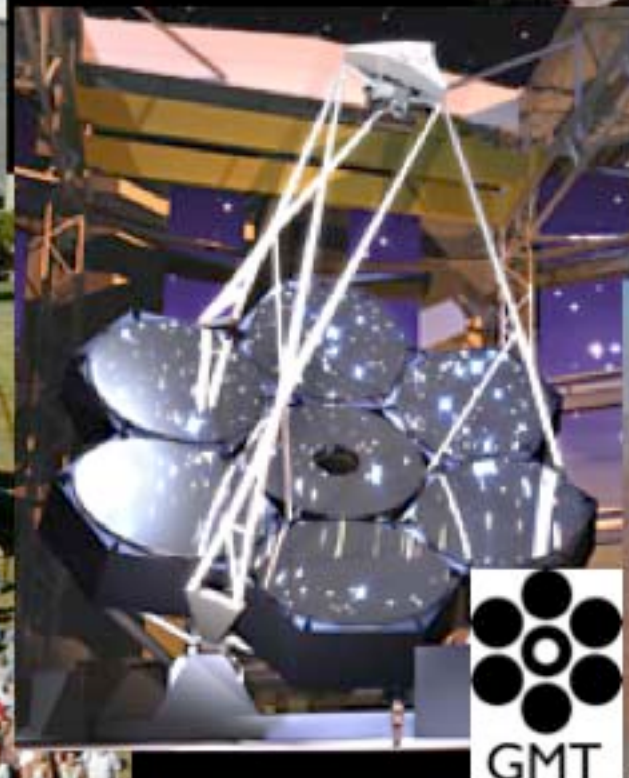
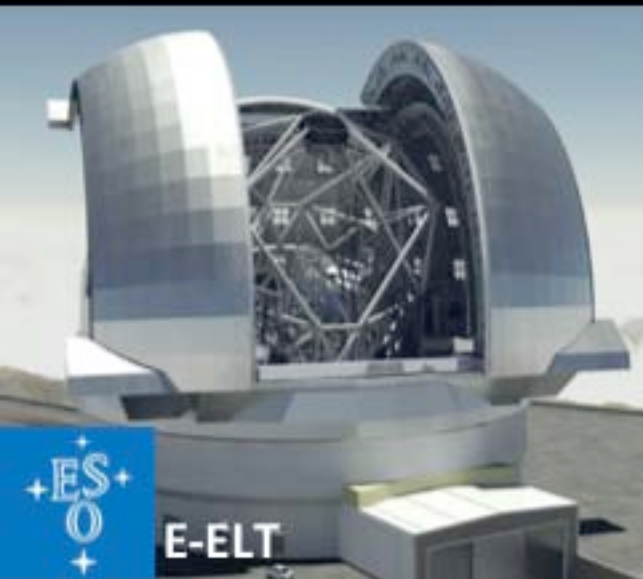
Moving at 17.26 km/s

Heliosphere



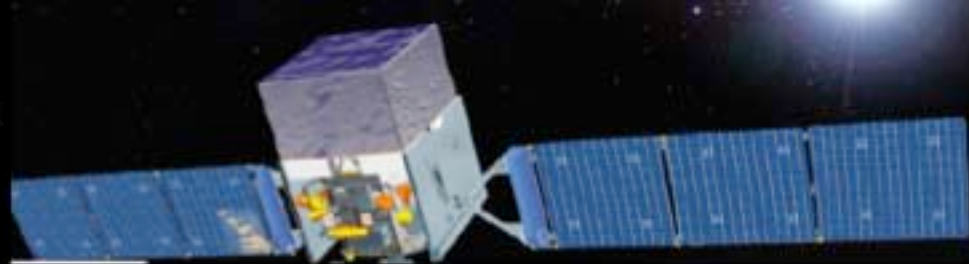
Ed Stone & Voyager

GREAT VISION for the FUTURE



Snowmass-CSS13; A. V. Olinto

CURRENT **JOINT** Projects



FERMI-LAT

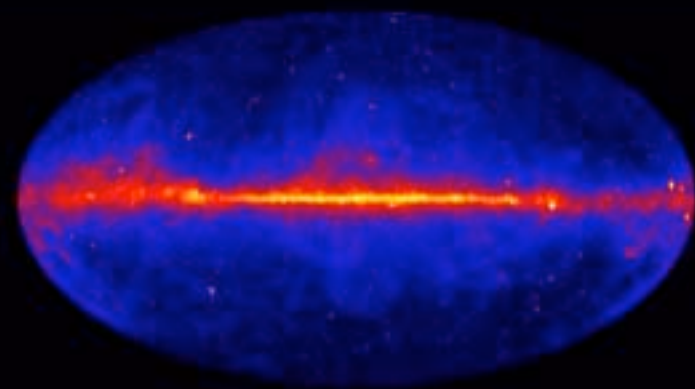


Dark Energy Survey

First Light 12 Sept 2012

8/5/13

Sno

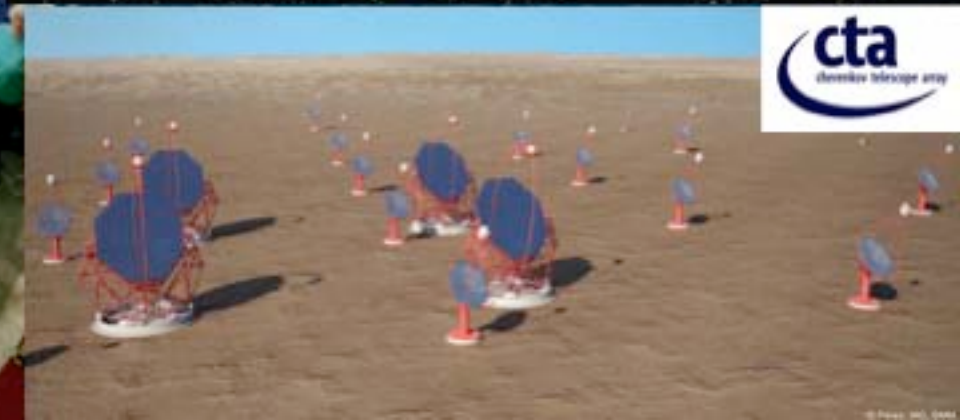
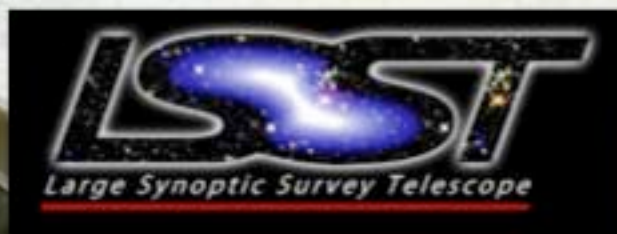


VERITAS



GREAT **JOINT** VISION for the FUTURE

WFIRST
Wide-Field Infrared Survey Telescope



Particle Physics and Astrophysics

SIMILARITIES – need for

LARGE INTERNATIONAL PROJECTS/FACILITIES

NEW DETECTOR TECHNOLOGIES

LARGE COMPUTATION EFFORTS

THEORETICAL NEW IDEAS & Guidance

Cosmic Frontier Instrumentation

● UHE-CR

- Low rates at high energy
- R&D: Radio Detection, detection of air shower from space

● UHE-neutrinos

- R&D: Need development of new antennas, low noise amplifiers for detection of Cherenkov radio emission

● Gamma rays

- R&D: Cherenkov and water tank arrays, Low-cost photosensors/low-power digitizers
- Distributed timing across large arrays

● Dark Energy

- R&D path: Low-resolution spectroscopy and spectroscopic capability to wide field optical surveys

● Dark Matter

- Large program looking for larger mass, lower thresholds and directionality

● CMB

- R&D path towards readout of large cryogenic multi-chroic arrays

8/5/13

D. Bortoletto, CSS 2013



Particle Physics and Astrophysics

SIMILARITIES – need for

LARGE INTERNATIONAL PROJECTS/FACILITIES

NEW DETECTOR TECHNOLOGIES

LARGE COMPUTATION EFFORTS

THEORETICAL NEW IDEAS & Guidance

Simulating the UNIVERSE

Eris simulation

J. Guedes and P. Madau

Millennium Simulation

Virgo Collaboration

2 Mpc h

2 Mpc/h

125 Mpc h

Particle Physics and Astrophysics

SIMILARITIES need for

LARGE INTERNATIONAL PROJECTS/FACILITIES

NEW DETECTOR TECHNOLOGIES

LARGE COMPUTATION EFFORTS

THEORETICAL NEW IDEAS & Guidance



Dark Energy?



Cosmological Constant???

Dark Energy?



Vacuum Energy???

Quintessence??

????

Particle Physics and Astrophysics

SIMILARITIES – need for

LARGE INTERNATIONAL PROJECTS/FACILITIES

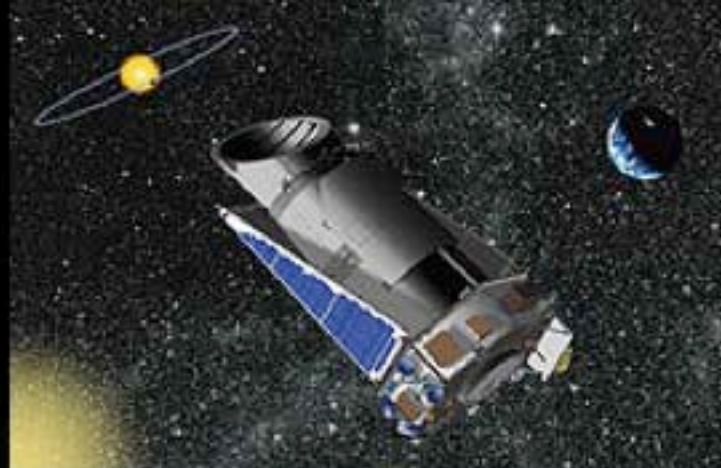
NEW DETECTOR TECHNOLOGIES

LARGE COMPUTATION EFFORTS

THEORETICAL NEW IDEAS & Guidance

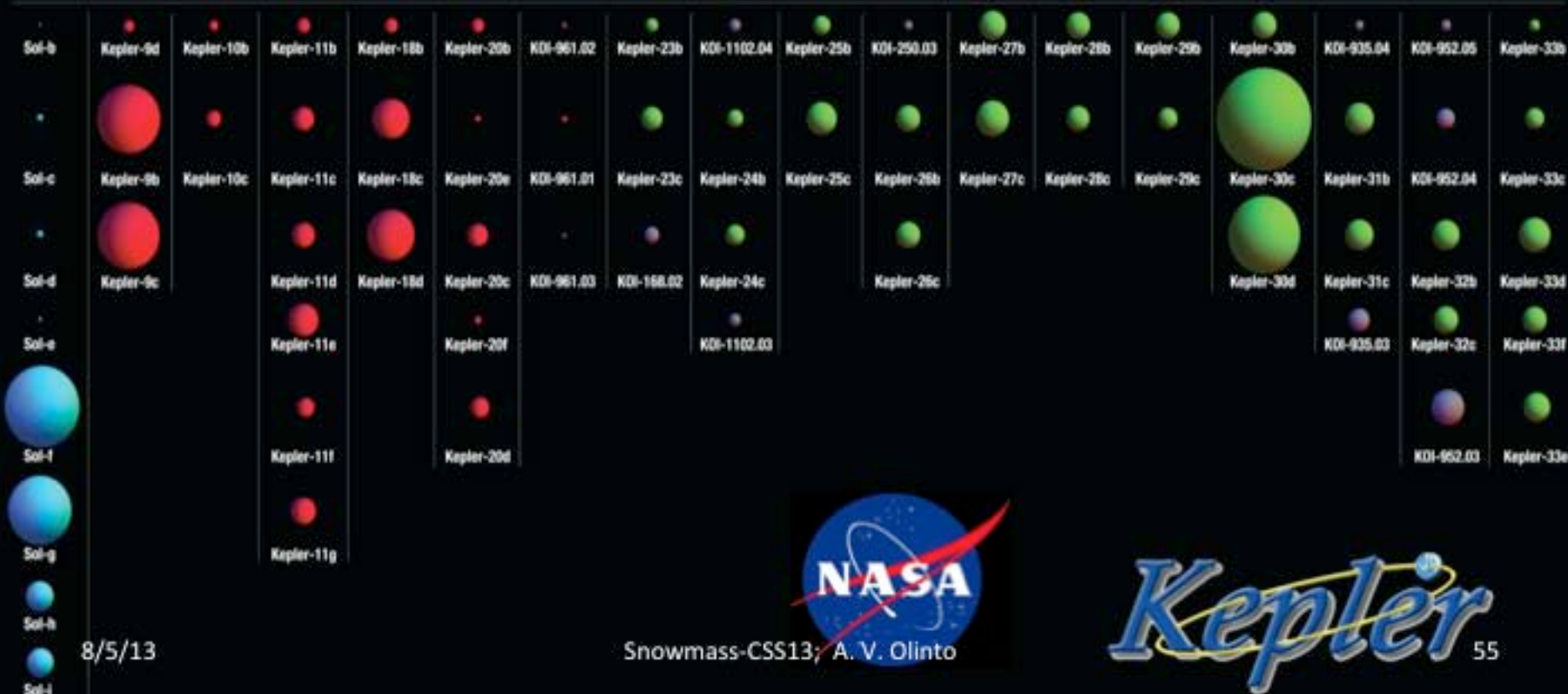
Kepler Mission

3,216 exoplanet candidates
132 confirmed



Kepler's Transiting Planet Systems

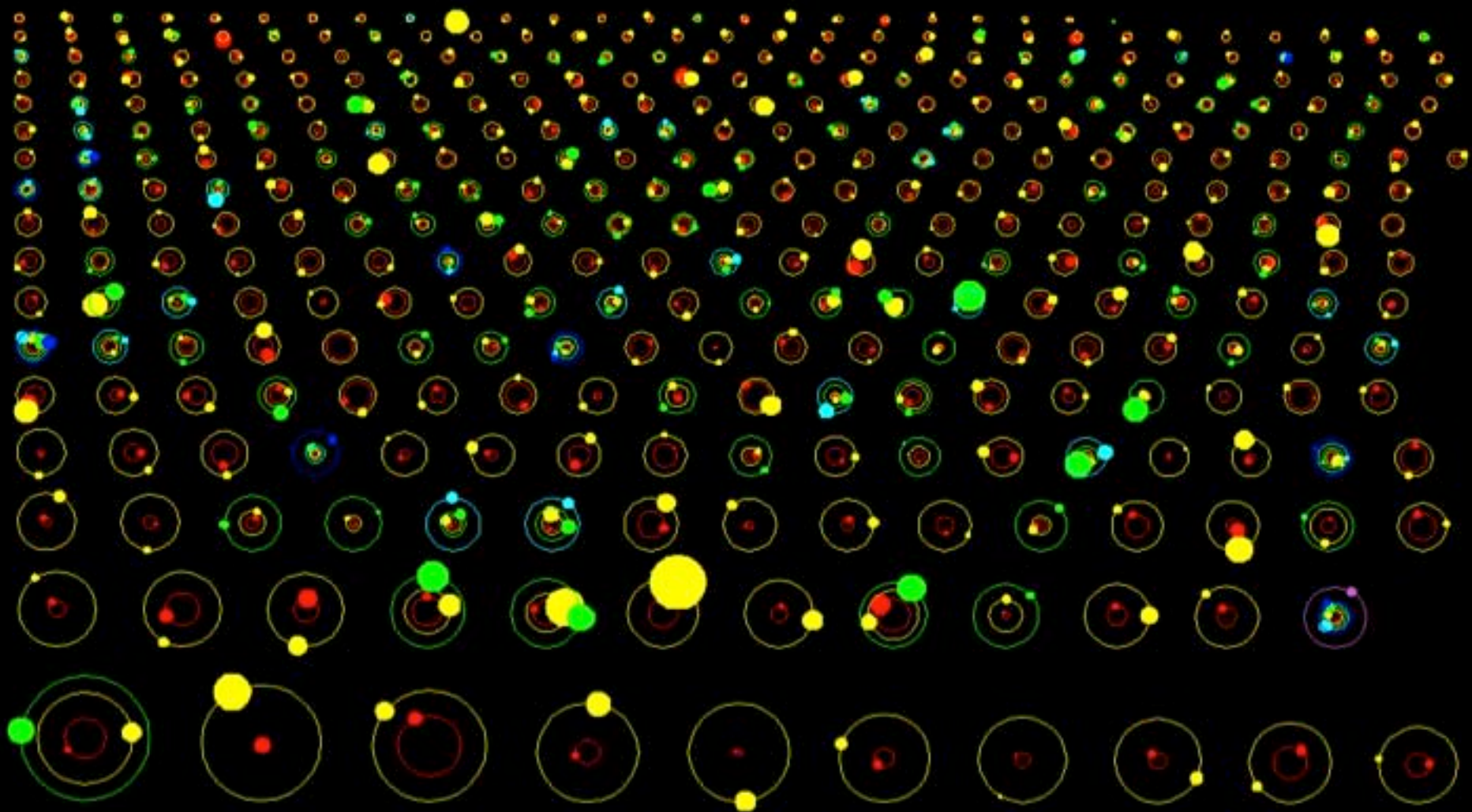
● Solar System
 ● Planetary systems known prior to January 26, 2012
 ● Planetary systems announced January 26, 2012
 ● Unconfirmed planet candidates



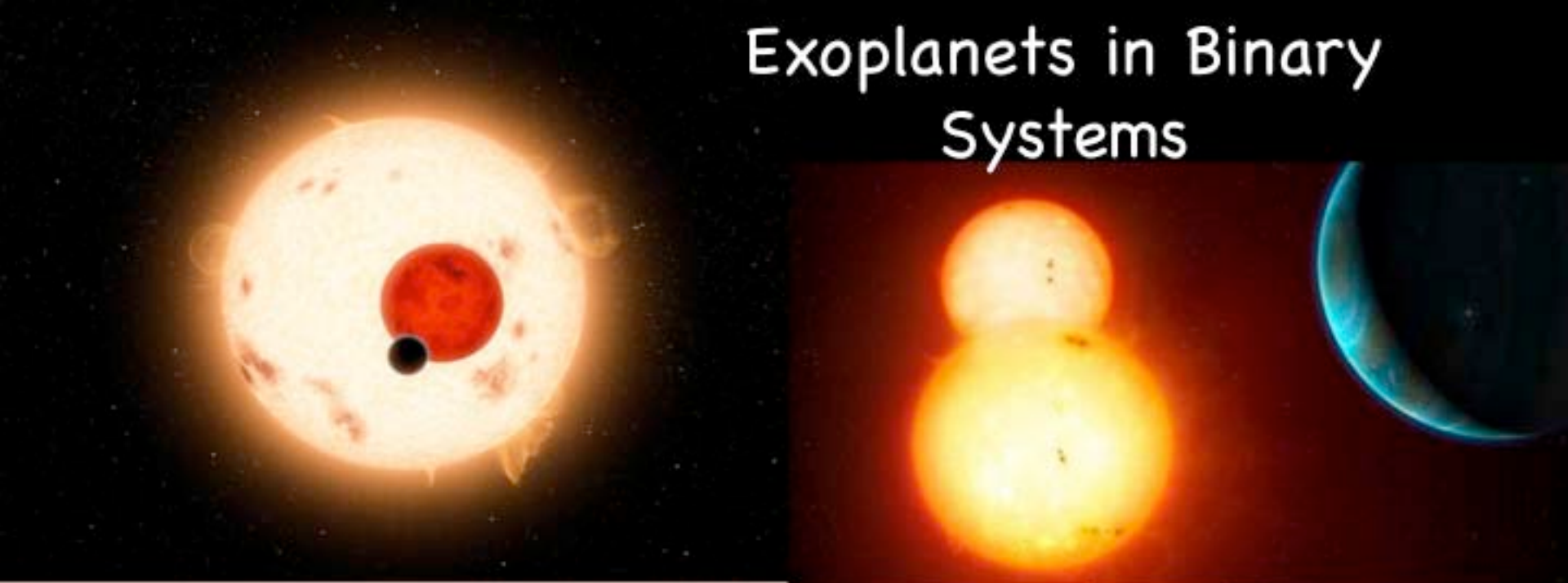
The Kepler Orrery II

$$t[\text{BJD}] = 2455879$$

D. Fabrycky 2012



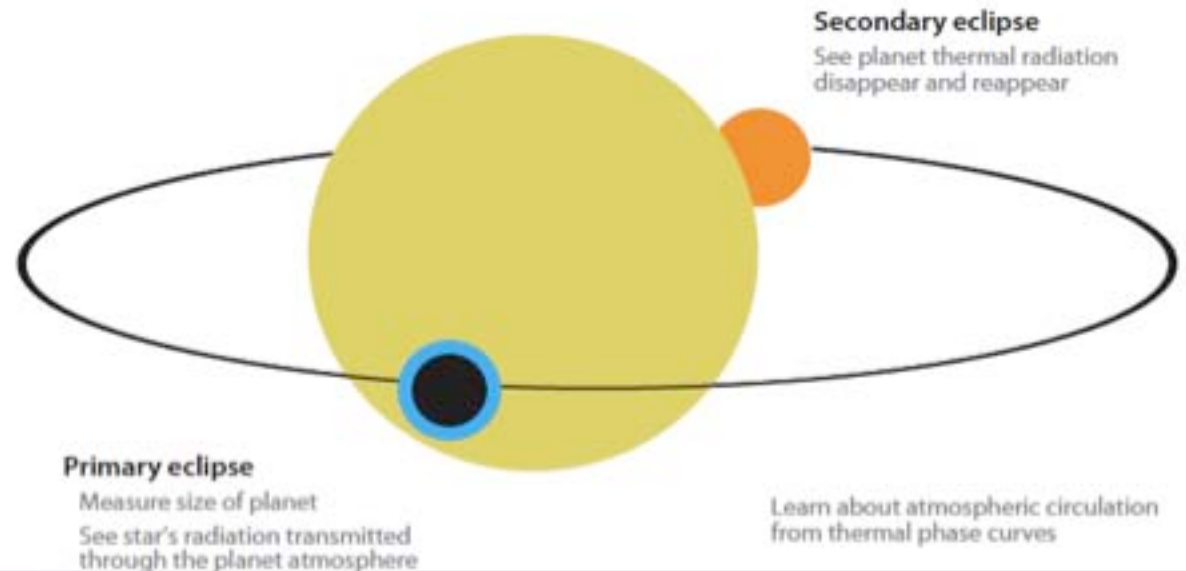
Exoplanets in Binary Systems



**Skywalker
on Tatooine**

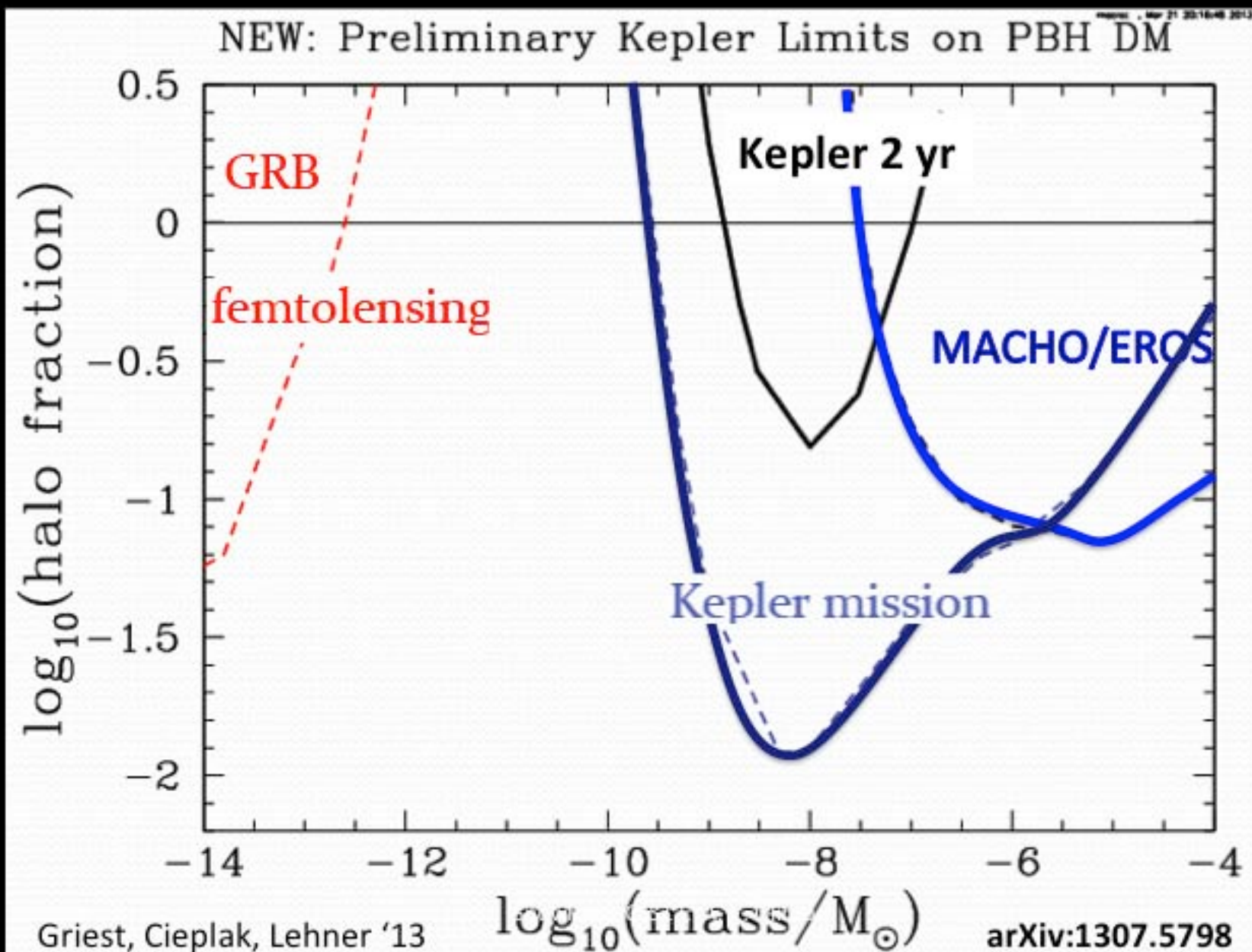
**STAR
WARS**

Exoplanet Search

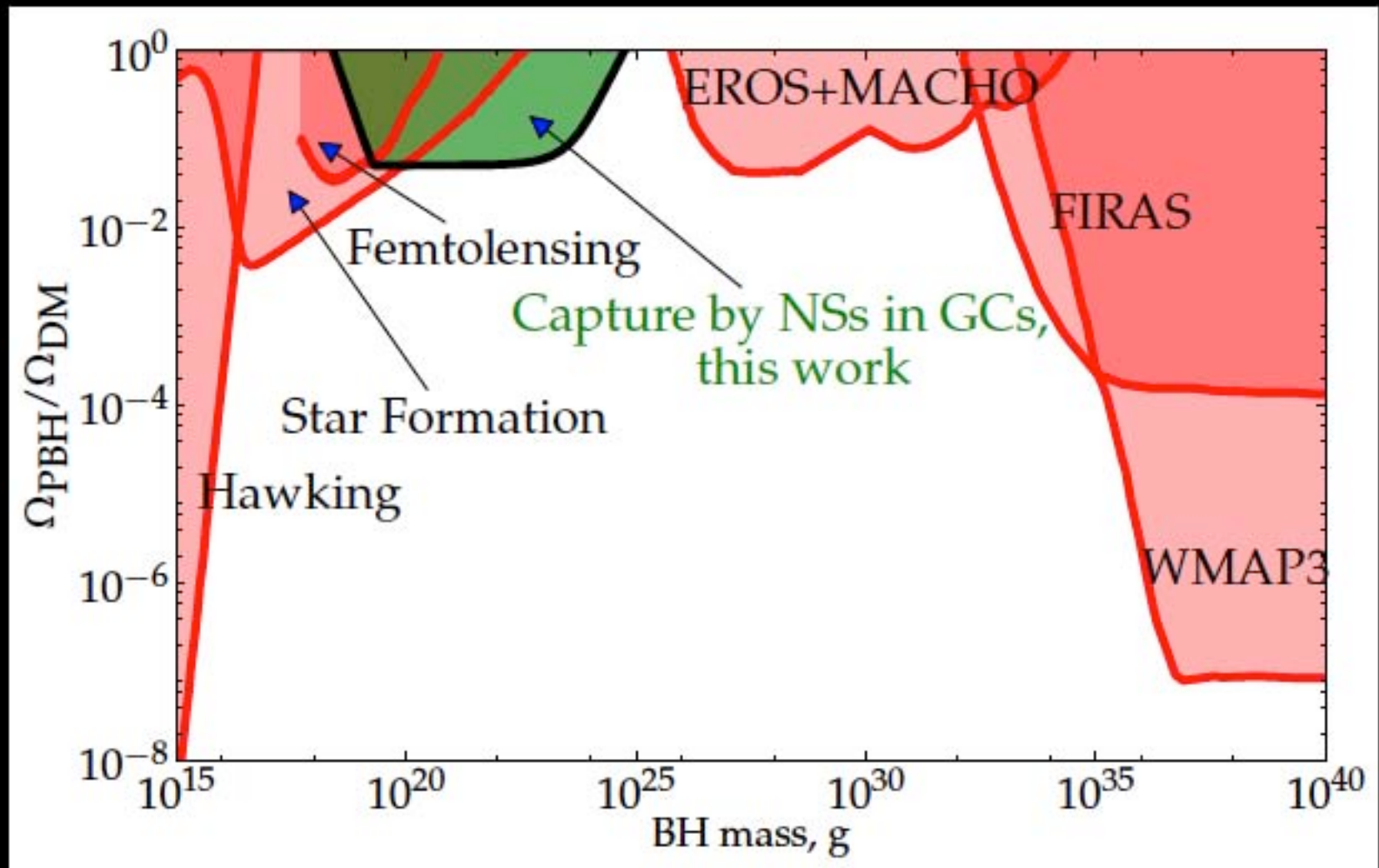


10 ppm precision
Transit Method

Primordial Black Holes as DM

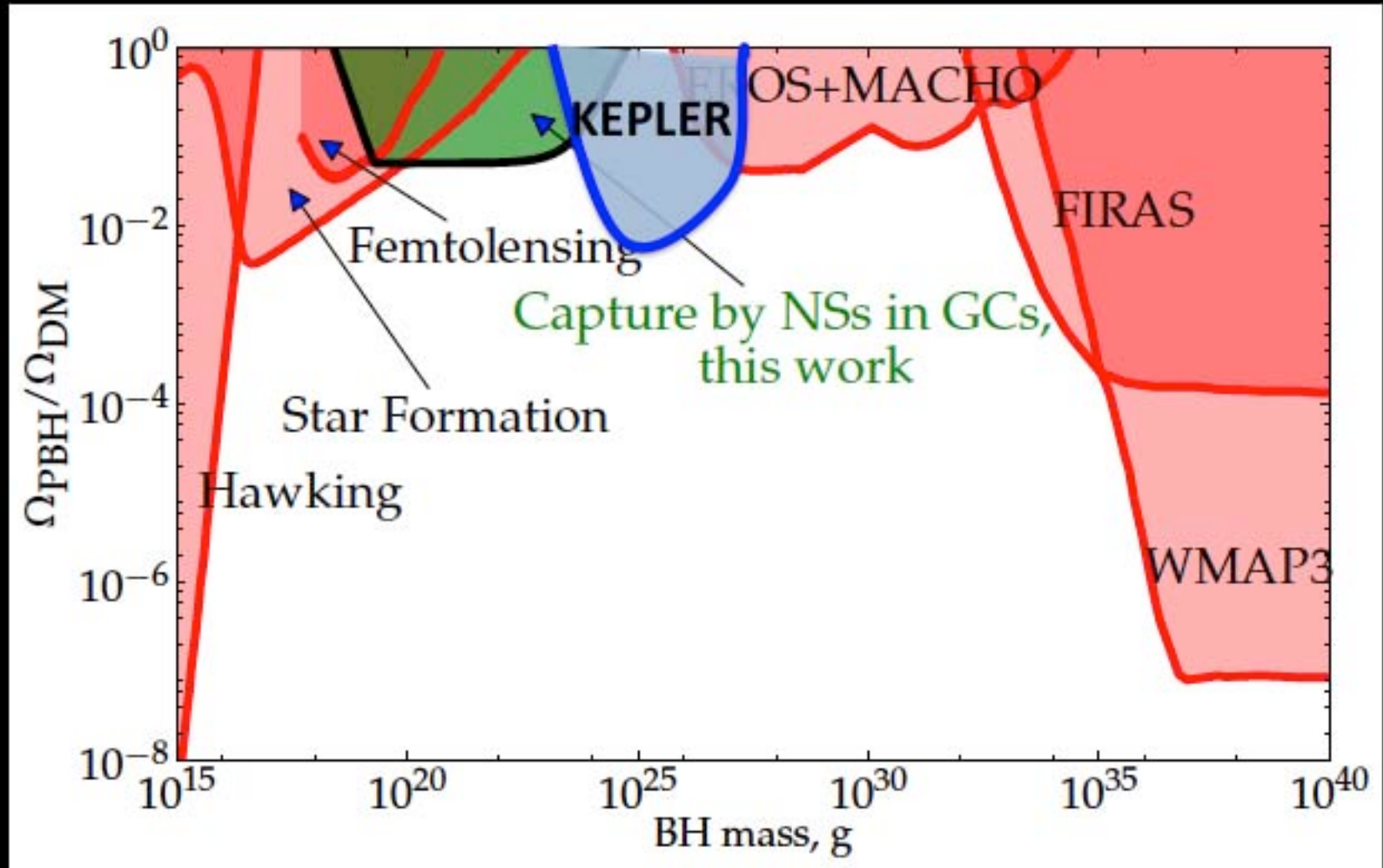


Closing the PBH as DM window



Capela, Pshirkov, & Tinyakov: arXiv:1301.4984

Closing the PBH as DM window



Capela, Pshirkov, & Tinyakov: arXiv:1301.4984

Cross-Fertilization

Particle Physics & Astrophysics

Some of the same questions with different approaches and perspectives

Similar tools: Brilliant Brains, Massive Computing, New Technologies, Large International Projects

Interdisciplinary efforts foment great new ideas.
Many surprises!

History of the Universe



COMMUNICATION & COLLABORATION
Between the two views of the UNIVERSE
is a win-win

Age of the universe (billions of years)



Seeing back into the cosmos

In Sum

We look forward to the conclusions of the Snowmass Process.

We invite joint DAP & DPF sessions on the Snowmass findings in the 2014 April Meeting.

In Sum

We look forward to the conclusions of the Snowmass Process.

We invite joint DAP & DPF sessions on the Snowmass findings in the 2014 April Meeting.

Join DAP for \$8/yr!!!!