



National Science Foundation Perspective

Jean Cottam & Jim Whitmore
Program Directors for Particle Astrophysics

Vistas in Axion Physics
Institute for Nuclear Theory, Seattle, WA
April 25, 2012

NSF Particle Astrophysics Program



The Particle Astrophysics program seeks to explore the fundamental nature of matter, energy, space, and time. It asks such questions as:

What are the origins of mass?

Can the basic forces of nature be unified?

How did the universe begin?

How will it evolve in the future?

What are dark matter and dark energy?

Are there extra dimensions of space-time?

Particle Astrophysics lies at the intersection of particle physics, astronomy and cosmology. Formerly separate questions in cosmology (the universe on the largest scales) and quantum phenomena (the universe on the smallest scales) become connected through our understanding that the early universe can be explored through the techniques of particle physics.

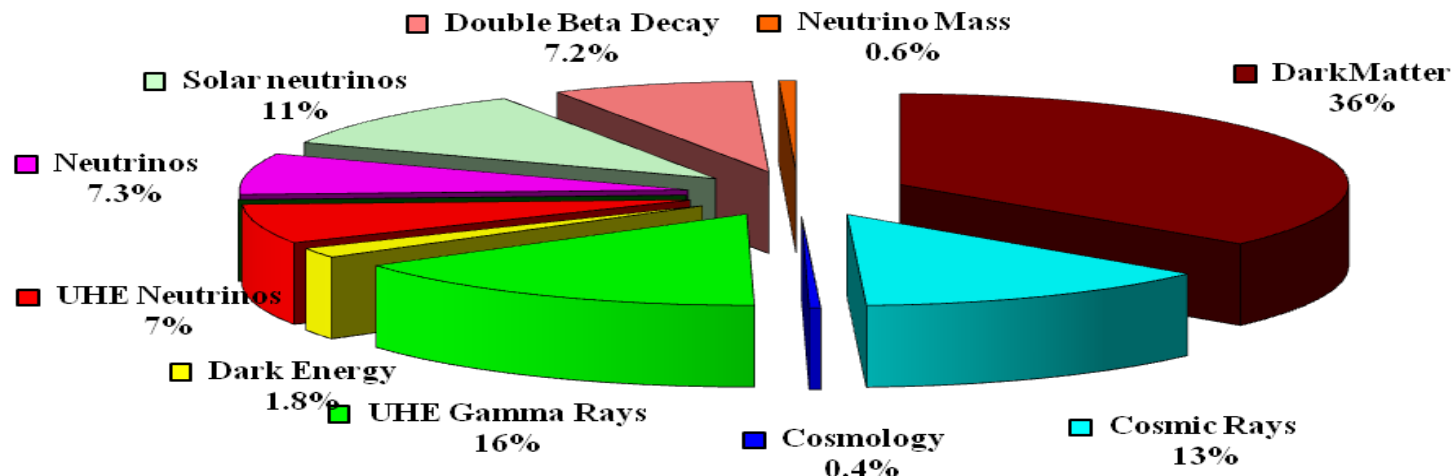
NSF Particle Astrophysics Program



Currently supported activities in FY11 Program:

- 36% Searches for **Dark Matter** particles through direct detection
- 36% Probing the **High Energy Universe** through the studies of cosmic rays, gamma-rays, and neutrinos
- 26% Measurements of solar neutrinos and attempts to determine the absolute value of the mass of **Neutrinos** as well as some of their elusive properties.
- 2.2% Studies of **Dark Energy** and **Cosmology**

PA funding by topic for FY2011



PA Supported Direct Dark Matter Experiments



WIMP – Spin-Independent

Super CDMS	Ge Target	Soudan	Commissioning/Ops
XENON100/1T	2 phase Xe Target	LNGS	Operations/R&D
LUX-350	2 phase Xe Target	SURF	Commissioning
WARP	2 phase Ar Target	LNGS	Finished
MiniCLEAN	Liquid Ar & Ne Target	SNOLab	Construction
Darkside50	2 phase Depleted Ar	LNGS	Construction

WIMP – Spin-Dependent

COUPP-60	Bubble Chamber	(SNOLab)	Commissioning
PICASSO	Superheated C ₄ F ₁₀	SNOLab	Operations
CoGeNT	Single Ge crystal PPCS	Soudan	Operations
DRIFT-II	Directional Gaseous TPC	Boulby	Operations
DMTPCino	Directional CF ₄ TPC	WIPP	Operations

Axion Searches

ADMX-HF	Microwave cavity	Yale	Construction
---------	------------------	------	--------------

PA Supported Axion Research



VOLUME 38, NUMBER 25

PHYSICAL REVIEW LETTERS

20 JUNE 1977

CP Conservation in the Presence of Pseudoparticles*

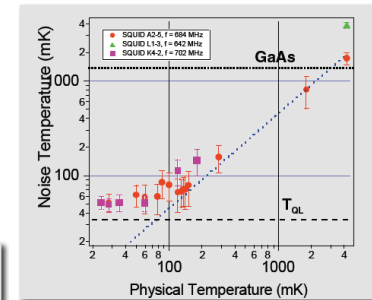
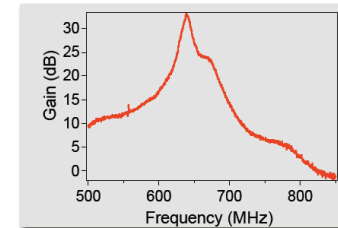
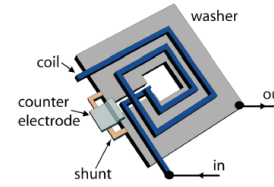
R. D. Peccei and Helen R. Quinn†

Institute of Theoretical Physics, Department of Physics, Stanford University, Stanford, California 9

(Received 31 March 1977)

We give an explanation of the *CP* conservation of strong interactions which includes the effects of pseudoparticles. We find it is a natural result for any theory where at least one flavor of fermion acquires its mass through a Yukawa coupling to a scalar field which has nonvanishing vacuum expectation value.

*Work supported in part by National Science Foundation Grants No. PHY 75-18444 and No. PHY 75-20427.



More than an order of magnitude quieter than current GaAs HFET amplifier

John Clarke
NSF PI (1996-1998)

VOLUME 40, NUMBER 4

PHYSICAL REVIEW LETTERS

23 JANUARY 1

A New Light Boson?

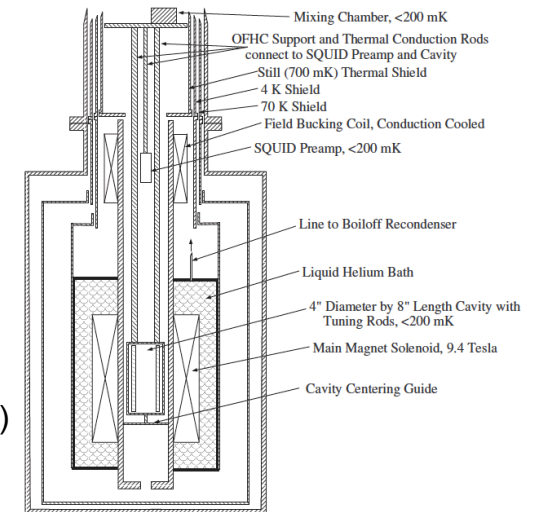
Steven Weinberg

Lyman Laboratory of Physics, Harvard University, Cambridge, Massachusetts 02138

(Received 6 December 1977)

It is pointed out that a global $U(1)$ symmetry, that has been introduced in order to preserve the parity and time-reversal invariance of strong interactions despite the effects of instantons, would lead to a neutral pseudoscalar boson, the "axion," with mass roughly of order 100 keV to 1 MeV. Experimental implications are discussed.

This research was supported in part by the National Science Foundation under Grant No. PHY 75-20427.

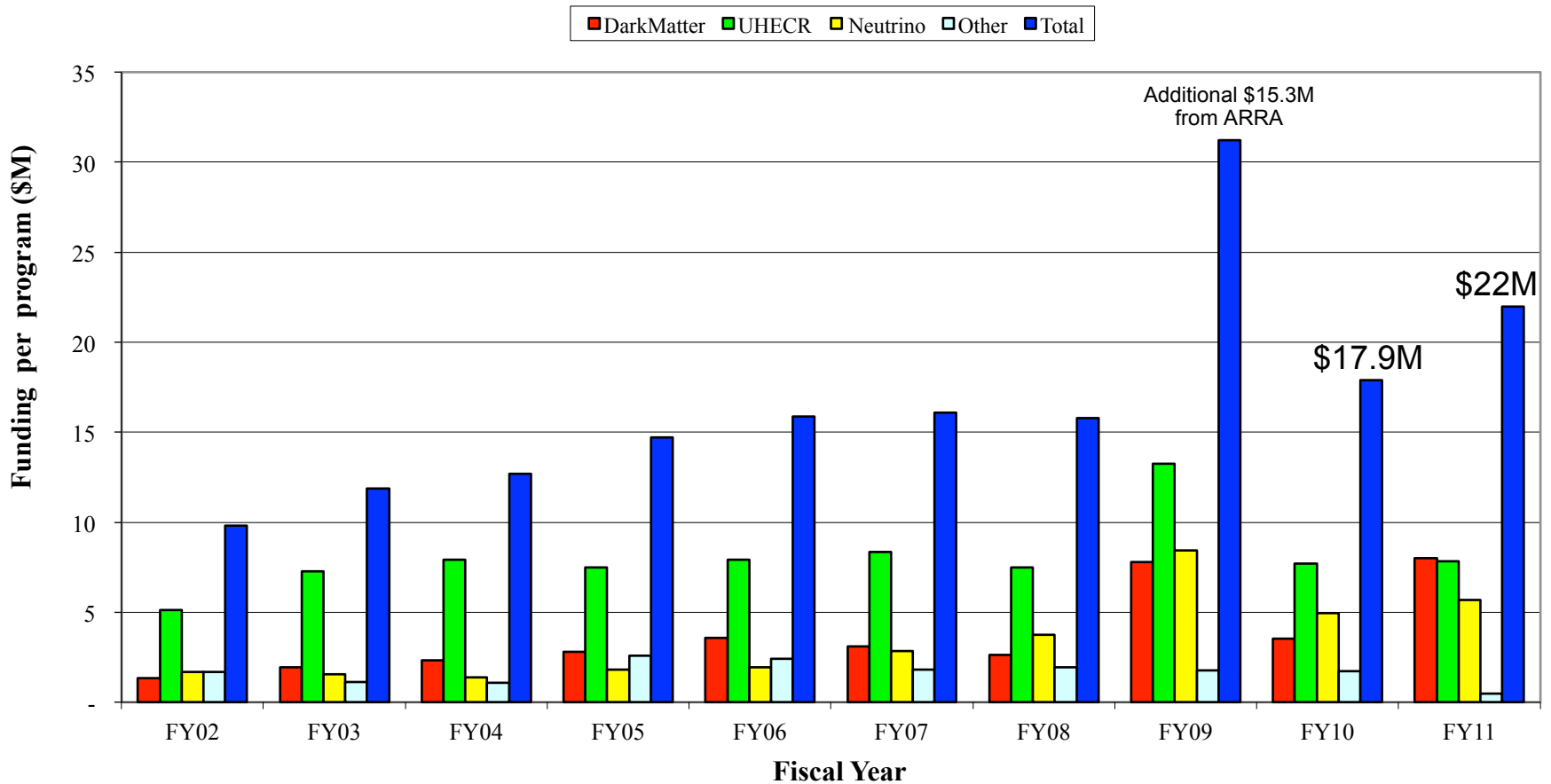


ADMX-HF (High Frequency)
S. Lamoreaux, Yale

PA Budget Context



Yearly Funding for PA Program (\$M)





PHY and MPS Budget Context

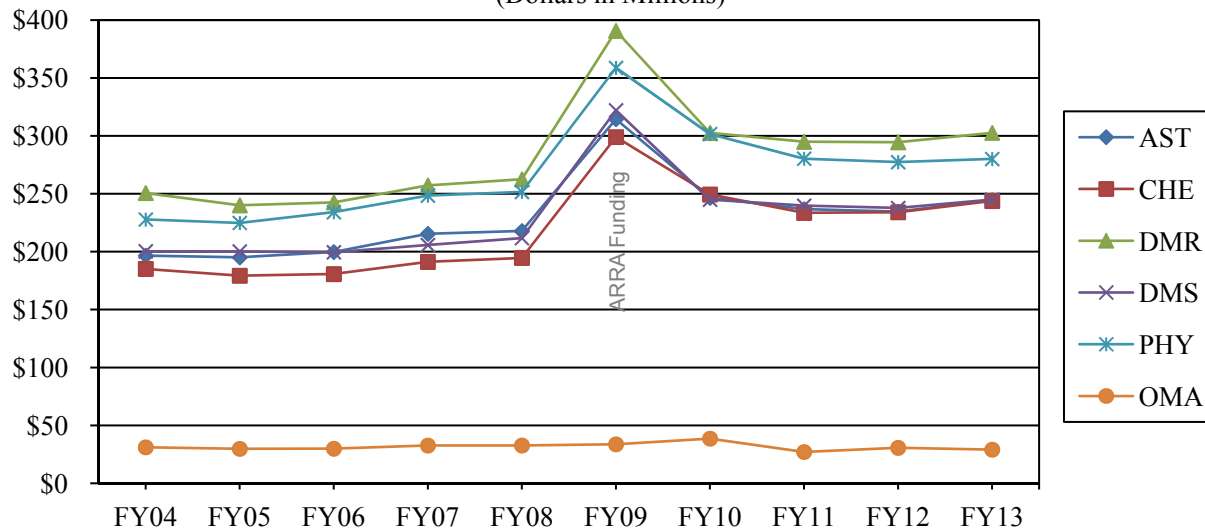
MPS Funding (Dollars in Millions)

	FY 2011 Actual	FY 2012 Estimate	FY 2013 Request	Change Over FY 2012 Estimate	
				Amount	Percent
Division of Astronomical Sciences (AST)	\$236.78	\$234.55	\$244.55	\$10.00	4.3%
Division of Chemistry (CHE)	233.55	234.06	243.85	9.79	4.2%
Division of Materials Research (DMR)	294.91	294.55	302.63	8.08	2.7%
Division of Mathematical Sciences (DMS)	239.79	237.77	245.00	7.23	3.0%
Division of Physics (PHY)	280.34	277.37	280.08	2.71	1.0%
Office of Multidisciplinary Activities (OMA)	27.06	30.64	29.07	-1.57	-5.1%
Total, MPS	\$1,312.42	\$1,308.94	\$1,345.18	\$36.24	2.8%

← Physics Division

Totals may not add due to rounding.

MPS Subactivity Funding (Dollars in Millions)



NSF Budget Context



National Science Foundation Summary Table FY 2013 Request to Congress

(Dollars in Millions)

NSF by Account	FY 2011 Actual	FY 2012 Estimate	FY 2013 Request	FY 2013 Request over:			
				FY 2011 Actual Amount	Percent	FY 2012 Estimate Amount	Percent
BIO	\$712.27	\$712.38	\$733.86	\$21.59	3.0%	\$21.48	3.0%
CISE	636.06	653.59	709.72	73.66	11.6%	56.13	8.6%
ENG	763.33	826.17	876.33	113.00	14.8%	50.16	6.1%
<i>ENG Programs</i>	<i>636.86</i>	<i>673.41</i>	<i>711.13</i>	<i>74.27</i>	<i>11.7%</i>	<i>37.72</i>	<i>5.6%</i>
<i>SBIR/STTR</i>	<i>126.47</i>	<i>152.76</i>	<i>165.20</i>	<i>38.73</i>	<i>30.6%</i>	<i>12.44</i>	<i>8.1%</i>
GEO	885.32	885.27	906.44	21.12	2.4%	21.17	2.4%
MPS	1,312.42	1,308.94	1,345.18	32.76	2.5%	36.24	2.8%
SBE	247.33	254.25	259.55	12.22	4.9%	5.30	2.1%
OCI ¹	300.75	211.64	218.27	-82.48	-27.4%	6.63	3.1%
OISE	49.03	49.85	51.28	2.25	4.6%	1.43	2.9%
OPP ²	440.70	435.87	449.74	9.04	2.1%	13.87	3.2%
IA	259.60	349.59	431.52	171.92	66.2%	81.93	23.4%
U.S. Arctic Research Commission	1.58	1.45	1.39	-0.19	-11.8%	-0.06	-4.1%
Research & Related Activities	\$5,608.38	\$5,689.00	\$5,983.28	\$374.90	6.7%	\$294.28	5.2%
Education & Human Resources	\$861.04	\$829.00	\$875.61	\$14.57	1.7%	\$46.61	5.6%
Major Research Equipment & Facilities Construction	\$125.37	\$197.06	\$196.17	\$70.80	56.5%	-\$0.89	-0.4%
Agency Operations & Award Management	\$299.29	\$299.40	\$299.40	\$0.11	0.0%	-	-
National Science Board	\$4.47	\$4.44	\$4.44	-\$0.03	-0.7%	-	-
Office of Inspector General	\$13.92	\$14.20	\$14.20	\$0.28	2.0%	-	-
OIG FY 2011 ARRA Obligations	\$0.08	-	-	-	-	-	-
Total, NSF	\$6,912.55	\$7,033.10	\$7,373.10	\$460.55	6.7%	\$340.00	4.8%

← MPS

Totals may not add due to rounding.

¹ FY 2011 Actual for OCI includes \$90.50 million in funds that were obligated in FY 2010, deobligated in FY 2011, and then obligated in FY 2011 to other projects in the OCI portfolio.

² Funding for OPP for FY 2011 excludes a one-time appropriation transfer of \$53.892 million, \$54.0 million less the 0.2% rescission, to U.S. Coast Guard per P.L. 112-10.

Science Community



NSF's mission is *“to promote the progress of science; to advance the national health, prosperity, and welfare; to secure the national defense; and for other purposes.”*

- The Particle Astrophysics Program is a highly flexible program that can respond to the science community and the dynamics of a rapidly evolving experimental field

We respond to proposals

- The program is coordinated with other agencies and offices of the federal government as well as with international organizations. We work closely with the Offices of High Energy Physics and Nuclear Physics at the DOE and coordinate with the Astronomy Division at NSF and the Astrophysics Division of NASA.
- We solicit advice and strategic direction from advisory committees such as the HEPAP and AAAC, and from the National Academy of Science.

Comments



We appreciate your efforts to plan and prioritize as a community. In a time of flat or decreasing budgets we cannot support every small group, and spreading funding too thin minimizes the potential for progress and real scientific breakthroughs.

Congratulations on your progress towards a highly successful workshop.

We look forward to your report!