



# AMHERST CENTER FOR FUNDAMENTAL INTERACTIONS

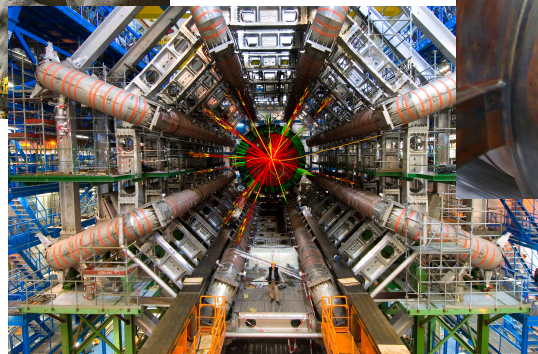
*Physics at the interface: Energy, Intensity, and Cosmic frontiers*

University of Massachusetts Amherst

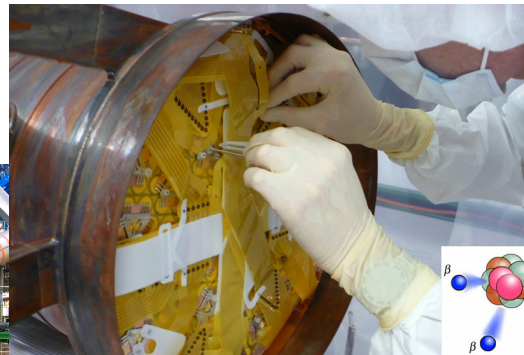
## Welcome to the ACFI !



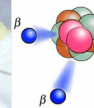
**LUX/LZ &  
DarkSide**



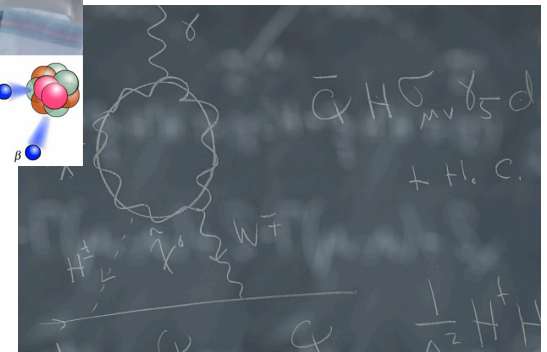
**ATLAS**



**EXO**



**Theory**





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*We seek answers to key open questions about nature's fundamental interactions, such as:*

*Why is there more matter than anti-matter in the Universe?*

*What additional forces were active during the first moments after the Big Bang?*

*How are protons and neutrons put together?*

## ***Our mission:***

*Advancing research in theoretical and experimental physics at the interface of the Energy, Intensity, and Cosmic frontiers.*

[\*http://www.physics.umass.edu/acfi/\*](http://www.physics.umass.edu/acfi/)



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### Activities

- **Core Research (in house):** *ATLAS, EXO, LUX/LZ, DarkSide, J Lab parity & chiral, RHIC Spin, Borexino, Theory*
- **Targeted Workshops:** *Hadronic Probes, Lambda & Quasi Lambda, Higgs Portal,...*
- **Visiting Researchers:** *Ph.D. students (Australia, China), post-docs, faculty & senior researchers*



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### Past Workshops

- *Hadronic Probes of Fundamental Symmetries*
- *Lambda and Quasi-Lambda*
- *Unlocking the Higgs Portal*
- *Measuring the Neutron Lifetime*
- *Fundamental Symmetry Tests w/ Rare Isotopes*
- *Time-Reversal Tests in Nuclear & Hadronic Processes*
- *Hadronic Matrix Elements for Probes of CP-Violation*
- *The CP Nature of the Higgs Boson*
- *Probing the EW Phase Transition at a Next Gen PP Collider*
- *LHC Searches for Long-Live BSM Particles*
- *Neutrino Mass: From the Terrestrial Laboratory to the Cosmos*
- *Recent Developments in Semiclassical Probes of QFT's*
- *Northeast Gravity Workshop*
- *Making the EWPT (Theoretically) Strong*
- *Neutrinos at the High Energy Frontier*
- *The Electroweak Box*





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### *Neutron Lifetime*

*arXiv:1410.5311*

#### **Determination of the Free Neutron Lifetime**

J. David Bowman,<sup>1</sup> L. J. Broussard,<sup>2</sup> S. M. Clayton,<sup>2</sup> M. S. Dewey,<sup>3</sup> N. Fomin,<sup>4</sup> K. B. Grammer,<sup>4</sup> G. L. Greene\*,<sup>4,1,†</sup>  
P. R. Huffman,<sup>5</sup> A. T. Holley,<sup>6</sup> G. L. Jones,<sup>7</sup> C.-Y. Liu,<sup>8</sup> M. Makela,<sup>2</sup> M. P. Mendenhall,<sup>3</sup> C. L. Morris,<sup>2</sup>  
J. Mulholland,<sup>4</sup> K. M. Nollett,<sup>9,10</sup> R. W. Pattie, Jr.,<sup>2</sup> S. Penttilä,<sup>1</sup> M. Ramsey-Musolf,<sup>11</sup> D. J. Salvat,<sup>8,2</sup>  
A. Saunders,<sup>2</sup> S. J. Seestrom,<sup>2</sup> W. M. Snow,<sup>8</sup> A. Steyerl,<sup>12</sup> F. E. Wietfeldt,<sup>13</sup> A. R. Young,<sup>5</sup> and A. T. Yue<sup>3</sup>



### *Hadronic Probes*



*J Lab proposal &  
Physics Reports*



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***EWPT @ 100 TeV***  
***arXiv: 1606.09408***

CERN-TH-2016-11

ACFI-T16-10

***Unlocking the Higgs Portal***  
***arXiv: 1604.05324***

**Physics at a 100 TeV  $pp$  collider: Higgs and EW symmetry breaking studies**

*Editors:*

*R. Contino<sup>1,2</sup>, D. Curtin<sup>3</sup>, A. Katz<sup>1,4</sup>, M. L. Mangano<sup>1</sup>, G. Panico<sup>5</sup>, M. J. Ramsey-Musolf<sup>6,7</sup>, G. Zanderighi<sup>1</sup>*

**The Higgs Portal and Cosmology**

Ketevi Assamagan,<sup>a</sup> Chien-Yi Chen,<sup>b,c</sup> John Paul Chou,<sup>d</sup> David Curtin,<sup>e</sup> Michael A. Fedderke,<sup>f</sup> Yuri Gershtein,<sup>d</sup> Xiao-Gang He,<sup>g</sup> Markus Klute,<sup>h</sup> Jonathan Kozaczuk,<sup>i</sup> Ashutosh Kotwal,<sup>j</sup> Steven Lowette,<sup>k</sup> Jose Miguel No,<sup>l</sup> Tilman Plehn,<sup>m</sup> Jianming Qian,<sup>n</sup> Michael Ramsey-Musolf,<sup>o</sup> Alexei Safonov,<sup>p</sup> Jessie Shelton,<sup>q</sup> Michael Spannowsky,<sup>r</sup> Shufang Su,<sup>s</sup> Devin G. E. Walker,<sup>t</sup> Stephane Willocq,<sup>o</sup> Peter Winslow<sup>o</sup>

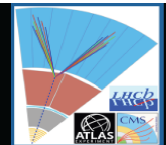


## ***Long Lived Particles @ LHC***

LHC **LLP** Community White Paper

Collecting the efforts of several workshops

- “LLP Signatures” — UMass — Nov. 2015
- “Experimental Challenges” — KITP — May 2016
- LHC LLP Mini-Workshop — CERN — May 2016 & April 2017





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## **Other Meetings & Events**

- **International Workshop on Baryon & Lepton Number Violation: 2015**
- **School on the Physics of Electric Dipole Moments: 2016**
- **Nuclear Theory Topical Collaboration: Neutrinoless Double Beta Decay & EDMs: 2017**
- **School on the Physics of Neutrinoless Double Beta Decay: 2017**



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## Upcoming Workshops & Schools

- Testing CPV for Baryogenesis: March 2018
- Neutron & Nuclear Beta-Decay (Fall 2018)



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### Support

- *Seed funding from UMass Amherst*
- *Department of Energy Office of Nuclear Physics (2018+)*
- *National Science Foundation (NLDBD School)*





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### Meeting Logistics

- **Wireless Network: UMASS (usr & pw in packet)**
- **Lunch: on campus**
- **WS Dinner: Thurs, Sat: on own in Amherst Center,  
Fri @ Monkey Bar Bistro, 6:30 pm**
- **Schedule: online**
- **People: students, post-docs, staff (Brittany Bonenfant)**
- **Espresso !**



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## **This Workshop: Motivation & Goals**

- Explaining the matter-antimatter asymmetry is a key open problem at the interface of nuclear & high energy physics with cosmology
- Advances in experimental CPV probes provide new opportunities to test baryogenesis scenarios
- Timely to share new ideas & developments in baryogenesis and to discuss possible experimental signatures