

FRIB Theory Alliance Summary

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(for the FRIB-TA Executive Board)



Theory Alliance
FACILITY FOR RARE ISOTOPE BEAMS



U.S. DEPARTMENT OF
ENERGY

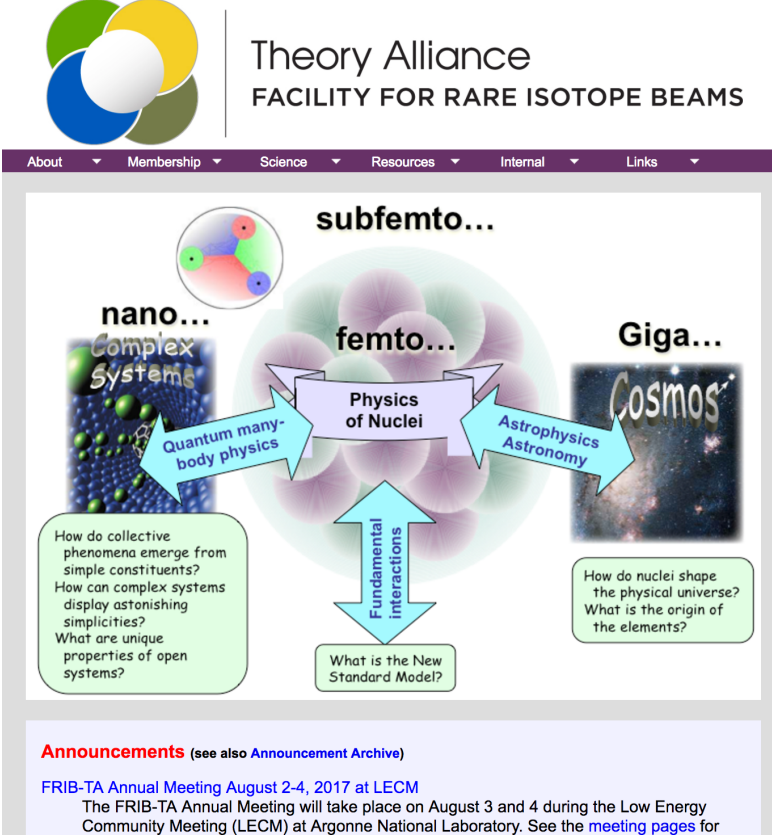
Office of
Science



FRIB Theory Alliance @ LECM 2017

- Participation in FRIB Day-1 Science Workshop
- FRIB Theory Alliance Workshop (3 sessions)
 - Town Meeting
 - Presentations by Fellows
 - Resolutions
 - FRIB Day-1 Physics discussion

FRIB-TA Website
fribtheoryalliance.org



The screenshot shows the website for the Theory Alliance at the Facility for Rare Isotope Beams (FRIB). The header includes the logo and the text "Theory Alliance FACILITY FOR RARE ISOTOPE BEAMS". Below the header is a navigation menu with links for "About", "Membership", "Science", "Resources", "Internal", and "Links". The main content area features a diagram illustrating the relationship between different scales of physics:

- subfemto...** (top center)
- nano... Complex Systems** (left)
- femto...** (center)
- Giga... Cosmos** (right)

Arrows indicate interactions between these scales:

- A double-headed arrow labeled "Quantum many-body physics" connects "nano... Complex Systems" and "femto...".
- A double-headed arrow labeled "Astrophysics Astronomy" connects "femto..." and "Giga... Cosmos".
- A double-headed arrow labeled "Fundamental interactions" connects "femto..." and "Physics of Nuclei".

Text boxes provide key questions:

- Left box: "How do collective phenomena emerge from simple constituents? How can complex systems display astonishing simplicities? What are unique properties of open systems?"
- Bottom center box: "What is the New Standard Model?"
- Right box: "How do nuclei shape the physical universe? What is the origin of the elements?"

At the bottom, there is an "Announcements" section (see also [Announcement Archive](#)) and a notice for the "FRIB-TA Annual Meeting August 2-4, 2017 at LECM". The notice states: "The FRIB-TA Annual Meeting will take place on August 3 and 4 during the Low Energy Community Meeting (LECM) at Argonne National Laboratory. See the [meeting pages](#) for..."



Timeline and scope

- FRIB-TA was a part of the LRP 2015 theory initiative
- **First cycle:** June 1st 2015 – May 31st 2017
 - Modest start (supported 2 FRIB theory fellows at 50%)
- FRIB-TA Inaugural meeting: March 31-April 1 2016
- **Second cycle:** renewal submitted at end of October 2016
 - Recommended for funding in May 2017
 - Expand fellow program (to grow from 2 to 4)
 - Implement bridge program (2 bridges by the end of the cycle)
 - Includes visitor program and meetings
 - Through May 31st 2020



Current FRIB-TA executive board

- Baha Balantekin (University of Wisconsin)
 - David Dean (**Director**, Oak Ridge National Laboratory)
 - Charlotte Elster (Ohio University, 2017)
 - George Fuller (University of California San Diego)
 - Richard Furnstahl (Ohio State University)
 - Charles Horowitz (University of Indiana, 2016)
 - Augusto Macchiavelli (Lawrence Berkeley National Lab, 2017)
 - Witek Nazarewicz (**Past Director**, Michigan State University)
 - Erich Ormand (Lawrence Livermore National Laboratory)
 - Jorge Piekarewicz (Florida State University, 2017)
 - Rebecca Surman (University of Notre Dame, 2016)
 - Michael Thoennessen (Michigan State University)
- Filomena Nunes (**Managing Director**, Michigan State University)



Thanks to members of the board that rotated off this year:

- Robert Janssens (Argonne National Laboratory)
- Bao-An Li (Texas A&M University - Commerce)
- Sanjay Reddy (INT, University of Washington)

FRIB theory fellow program

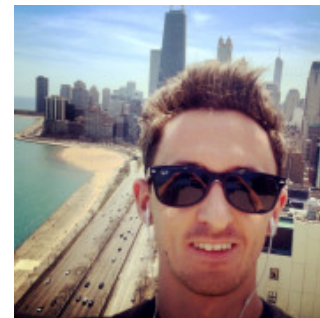
- Fellow positions serve to retain the best in the field and provide a stepping stone for a permanent position:
 - Not a postdoc – independent research program and travel budget
 - Modeled after INT fellows
- Currently there are 2 fellows (1 at MSU, 1 at a partner institution)
- Renewal builds up to 4 fellows (1 at MSU, 3 at a partner institution)
- Long term plan: 6 fellow positions (2 at MSU and 4 nationally)

- 50% compensation (salary/travel) by host
- Fellow should spend a significant amount of time at FRIB (flexibility!)
- Goal is to conduct a fellow search every year

Gregory Potel
(fellow 2016, at MSU)
Expertise in reaction
theory



Diego Lonardoni
(fellow 2015, at LANL)
Expertise in QMC



FRIB theory bridge program

Introduce several faculty/staff positions across the U.S. (not at MSU) (proposal to search for the second bridge faculty in the 2nd cycle of FRIB-TA grant)

- 50% compensation (salary/travel) by DOE for a fixed period (5-6 yrs)
- Faculty/staff should spend a significant amount of time at FRIB
- Call for proposals from physics departments and national labs
- FRIB Theory Bridge committee makes the selection of a host
- Host institution runs the search
- Final candidate needs to be vetted by the FRIB-TA board



First FRIB-TA Bridge Search!

Faculty Opening, Nuclear Theory Washington University in St. Louis

The Department of Physics at Washington University in St. Louis invites applications to fill a tenure-track faculty opening at the Assistant Professor level in Nuclear Theory with relevance to the Facility for Rare Isotope Beams (FRIB) at Michigan State University (MSU). The search involves a position that is initially 50% funded by MSU through its FRIB theory alliance (FRIB-TA) until the successful candidate receives tenure. The appointment will begin Fall 2018. Information on our department can be found at <http://www.physics.wustl.edu> while information about FRIB can be found at <https://frib.msu.edu/>. Candidates should have a Ph.D. in Physics or a closely related field at the time of appointment, significant research achievements, and an aptitude for teaching physics at the graduate and undergraduate levels. Duties will include, but are not limited to, conducting original research and writing for publication, teaching courses, advising students, and participating in department and university service. The successful candidate will carry the usual teaching load of one course per semester on average but is expected to spend a significant amount of time at FRIB. Applications should be submitted electronically to nucleartheorysearch@physics.wustl.edu and should consist of a single file in PDF format containing a cover letter, a current résumé including publication record, a statement of research interests and plans (up to 4 pages), a statement of teaching interests and approach (up to 2 pages), and names and contact information of three references. Applications received by **December 1, 2017** will receive full consideration. *Washington University is an Equal Opportunity Employer. All qualified applicants will receive consideration for employment without regard to race, color, religion, age, sex, sexual orientation, gender identity or expression, national origin, genetic information, disability, or protected veteran status.*



FRIB-TA Broader Impact

FRIB theory activities center on low energy nuclear reactions, nuclear structure and response, and the nature and behavior of dense nuclear matter. These subjects have strong overlap with the FRIB experimental effort, but they also figure prominently in other areas of nuclear physics, particle physics, astrophysics and cosmology, and the “Big Questions”, e.g., the origin of the elements, the origin of neutrino mass, the nature of dark matter . . .

- Gravitational Wave and Multi-Messenger Astronomy
- Neutrinos and Fundamental Symmetries/Particle Physics/Cosmology
- Many body physics/Complex systems/Open quantum systems
- Large scale computations

We should facilitate broader impact in these and other science opportunity areas

- Interdisciplinary meetings (partnering with INT and ECT*)
- Identify a pool of colloquia speakers to spread good news
- ...



FRIB-TA International Links

International collaborations in nuclear theory (**ICNT**) introduced in 2012. Running programs yearly since then. Strong cooperation with INT envisaged.

Europe-US Theory Initiative on the Physics for Exotic Nuclei (**EUSTIPEN**) has been proposed around the ECT* in Trento. The European portion of its funding would come through the European Nuclear Science and Applications Research Program ENSAR2, funded by the European Commission. FRIB-TA would provide travel support, primarily for junior scientists, based in the U.S., to participate in EUSTIPEN activities, relevant for the physics of exotic nuclei. It is anticipated that EUSTIPEN will involve ECT*, ENSAR2, INT, and FRIB-TA.

Two nuclear junior theorists have been selected as the **FRIB-CSC Research Fellows** for 2017. Funding for the Fellows is provided by the China Scholarship Council, with a supplement from the US host institutions. There was a very good interest in the 2017 search. The two fellows will join UTK/ORNL and ISU theory groups. More FRIB-CSC theory fellows are expected to join the FRIB-TA during the next years.

FRIB-TA Education

<http://fribtheoryalliance.org/content/education.php>

The FRIB-TA will work with the community and the TALENT initiative to improve education in nuclear theory.

The FRIB-TA Education Committee is coordinating efforts to produce a survey class exclusively on contemporary research in nuclear physics, targeted at upper-level undergraduates (although also suitable for beginning graduate students). Full-semester survey courses of this type that will serve as pilot versions have been developed recently at Michigan State University (MSU) and Ohio State University (OSU), both using as textbooks the NRC report Nuclear Physics: Exploring the Heart of Matter and the 2015 NSAC Long Range Plan Reaching for the Horizon (with supplementary resources on the basics of nuclear physics).

MSU course website:

<https://people.nscl.msu.edu/~witek/Classes/PHY802/NuclPhys802-2017.html>

OSU course website:

<https://www.physics.ohio-state.edu/~ntg/6805/>



FRIB-TA recommendations (adopted unanimously by the FRIB-TA Town Meeting)

In support of our science goals, we must continue forefront nuclear theory research to realize the full potential of the experimental program at FRIB, to enable new discoveries, and to train the next generation of scientists. Consistent with the 2015 Long Range Plan, we therefore recommend:

- Full support of the FRIB Theory Alliance; in particular, the FRIB bridge and theory fellow programs at universities and national laboratories;
- New investments in computational nuclear theory and related astrophysics in order to take maximum advantage of high performance computing, which is critical to the overall effort;
- Broad support for educational initiatives including Training in Advanced Low-Energy Nuclear Theory (TALENT).



FRIB Day 1 Science at the 2017 Low Energy Community Meeting

Time	Topic	Speaker
	FRIB Status and Overview: Chair: Kelly Chipps (ORNL)	
1:00pm	Workshop Goals	FRIBUEC
1:10pm	FRIB Facility Overview	Thomas Glasmacher (FRIB)
1:50pm	FRIB Equipment	Georg Bollen (FRIB)
2:30pm	Break	
	Physics Session I: Chair: Carl Brune (OU)	
3:00pm	Astrophysics	Melina Avila (ANL) and Rebecca Surman (ND)
3:30pm	Reactions	Bob Charity (WashU) and Charlotte Elster (OU)
4:00pm	Break	
	Physics Session II: Chair: Filomena Nunes (MSU)	
4:15pm	Structure	Mitch Allmond (ORNL) and Ragnar Stroberg (TRIUMF)
4:45pm	Fundamental Symmetries	Jaideep Singh (MSU) and Jon Engel (UNC)
5:15pm	Applications	Greg Severin (MSU)
5:30pm	Discussion -- Chair: Lee Sobotka (WashU)	
6:00pm	Adjourn	



Theory input to Day-1 discussions

Scott Bogner

Diego Lonardoni

Paweł Danielewicz

Petr Navratil

Wim Dickhoff

Witek Nazarewicz

Charlotte Elster

Filomena Nunes

Jon Engel

Jorge Piekarewicz

Dick Furnstah

Sofia Quaglioni

Alexandra Gade

Nicolas Schunck

Gaute Hagen

Ragnar Stroberg

Heiko Hergert

Rebecca Surman

Dean Lee

James Vary

Bao-An Li

Jun Xu

+ Bruce Barrett, Jutta Escher, Lucas Platter,...



Day-1 Discussion

(over 30 participants + 6 remote participants)

- Has important science been missing from workshop's presentations?
 - Are we missing the forest for the trees? Are we bold enough?
- Readiness factor:
 - Are we ready to provide meaningful support to Day-1 experimental program?
 - If not, what are the weakest links?
 - Having identified weaknesses, how do we fix them to be ready for Day-1?



Some topics discussed

- Central collisions to probe 0.7 to 2 times nuclear densities. Theory needed to extract the nuclear EOS.
- Understanding the dripline of Ca. Probing the transition from shell-model/mean-field to correlation-dominated regime.
- Proton-neutron correlations and transfer reactions along $N=Z$ line for heavy systems. $T=0$ and $T=1$ pairing. Concerted efforts with reaction theory.
- Structure of unbound proton-rich systems, multi-proton emitters.
- Charge-symmetry breaking: theory needs to treat Coulomb properly.
- Charge-exchange reactions not well understood. Measurements from FRIB for the complete GT strength. Important (p,n) direction - interesting to go the other way (d,pp) .
- Beta decays of very neutron rich would also inform electro-weak physics.
- Masses and beta decays for r-process modeling.
- Increased awareness of the key role of reaction theory that provides the link between experiment and structural observables.

Great discussions overall. To be continued!



- National FRIB-TA is growing (infant → toddler)
- Active in several areas
- A well-developed **plan** in place
- We want to be a reliable partner for Day-n FRIB science
- We would like to hear from you; your input is important

See you soon!

And many thanks to the ANL Physics Division for hosting our annual meeting and feeding us so well!

