Matthew Mumpower

Curriculum Vitae

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Education

2007–2012 **Ph.D. Nuclear Astrophysics**, *North Carolina State University*, Raleigh, NC.
2003–2007 **B.S. Physics**, *North Carolina State University*, Raleigh, NC.
2003–2007 **B.S. Applied Mathematics**, *North Carolina State University*, Raleigh, NC.

Ph.D. Thesis

title *The Rare Earth Peak : An Overlooked r-Process Diagnostic*
supervisor Gail McLaughlin
overview The r-process is the sequence of nuclear reactions responsible for approximately half the heaviest elements in the universe. We explore the mechanisms by which the rare earth nuclei are formed during the r-process. We find that nuclear data, including neutron capture rates and neutron separation energies, influence not only the final shape of the peak but also when it forms. Using new and independent constraints on the r-process we isolate astrophysical conditions favorable for elemental production in this region. We show that influential rare earth nuclei lie 10-15 neutrons from stability. These nuclei could potentially be measured in future radioactive beam facilities.

Employment

2015–present **Postdoctoral Researcher**, *LANL*, Los Alamos, NM.
2012–2015 **JINA Postdoctoral Fellow**, *ND*, Notre Dame, IN.
2008–2012 **Research Assistant**, *NCSU*, Raleigh, NC.
2007–2008 **Teaching Assistant**, *NCSU*, Raleigh, NC.
2005 (summer) **Research Assistant**, *University of Chicago*, Chicago, IL.
2004–2006 **Teaching Assistant**, *NCSU*, Raleigh, NC.

Postdocs Mentored

2016–present **Nicole Vassh**, *ND*, Reverse engineering nuclear properties using astrophysical observations.

Graduate Students Mentored

2016–present **Trevor Sprouse**, *ND*, PRISM: A reaction network framework for nuclear astrophysics.
2016–present **Erika Holmbeck**, *ND*, Fission in the r-process and PRISM.
summer 2017 **Alex Dombos**, *MSU*, Investigation of nu-bar and its impact on fission in the r-process.

Undergraduate Students Mentored

2013–2016 **Trevor Sprouse**, *ND*, PRISM: A reaction network framework for nuclear astrophysics.
2013–2015 **Kevin Lee**, *ND*, User frontend and chart of nuclides for Notre Dame nuclear database.
2013–2015 **Tim Khouw**, *ND*, Search capabilities and API for the Notre Dame nuclear database.
2012–2015 **Patrick Fasano**, *ND*, Initial development of the Notre Dame nuclear database.
2011–2012 **Caleb Marshall**, *NCSU*, β-decays in the rare earth region of the r-process.

Undergraduate Teaching

2011-2016 **ND**, Research mentor for students.
Spring 2008 **NCSU**, *PY205*, Lab instructor for Honors Sec 251 (classical physics).
Spring 2008 **NCSU**, *PY205*, Lab instructor for Honors Sec 252 (classical physics).
Spring 2008 **NCSU**, *PY205*, Lab instructor for Honors Sec 254 (classical physics).
Fall 2007 **NCSU**, *PY201*, Lab instructor for Honors Sec 201 (classical physics).
Fall 2007 **NCSU**, *PY201*, Lab instructor for Honors Sec 202 (classical physics).
Fall 2007 **NCSU**, *PY201*, Lab instructor for Honors Sec 203 (classical physics).
Spring 2006 **NCSU**, *PY205*, Lab instructor for Honors Sec 220 (classical physics).
Spring 2006 **NCSU**, *PY205*, Lab instructor for Honors Sec 221 (classical physics).
Fall 2005 **NCSU**, *PY203*, Lab instructor for Sec 200 (modern physics).
Fall 2005 **NCSU**, *PY203*, Lab instructor for Sec 201 (modern physics).
Spring 2005 **NCSU**, *PY205*, Lab instructor for Honors SEC 200 (classical physics).
Spring 2005 **NCSU**, *MA231*, Lecture assistant (calculus).
Fall 2004 **NCSU**, *MA341*, Teaching assistant (differential equations).

Workshops & Schools

06/2016 **ICNT**, *r-process Workshop*, East Lansing, MI.
07/2015 **CETUP***, *Nuclear Astrophysics Workshop*, Deadwood, SD.
10/2014 **Hawaii DNP**, *Explosive Nucleosynthesis Workshop*, Waikoloa, HI (*organizer*).
09/2014 **FAIRNESS**, *FAIRNESS Workshop*, Vietri Sul Mare, Italy.
08/2014 **INT**, *INT r-Process Workshop*, Seattle, WA.
06/2014 **RIBSS**, *Radioactive Ion Beam Stweardship Retreat*, East Lansing, MI.
06/2013 **GRC**, *Gordon Research Conference Nuclear Chemistry*, New London, NH.
05/2013 **ORNL**, *β-Delayed Neutron Emission Workshop*, ORNL Oak Ridge, TN.
11/2012 **JINA**, *NAVI-JINA EoS Workshop*, NSCL East Lansing, MI.
08/2012 **NIC-XII**, *ANU Nuclei in the Cosmos School*, Canberra, Australia.
06/2011 **NNPSS**, *National Nuclear Physics Summer School*, UNC Chapel Hill, NC.
04/2011 **NRNS**, *Nuclear Reaction Network School*, Chiemsee, Germany.
07/2010 **NIC-XI**, *WE-Heraeus School: Astrophysics & The Cosmos*, Darmstadt, Germany.
06/2009 **Connecting Quarks & Cosmos**, *School On Particle Astrophysics*, Seattle, WA.

06/2009 **Workshop**, *Astrophysics & The Cosmos*, UNC Chapel Hill, NC.

Programming Experience & Computer Skills

Scientific Computing Built multiple beowulf supercomputing clusters • Runs large scale numerical calculations • Written object oriented nuclear reaction network • Experienced open source developer • Statistical Bayesian analysis techniques • Knowledge of machine learning • Monte Carlo studies • Open source database of nuclear properties in collaboration with the JINA and the Mozilla Science Foundation built by undergraduates • high performance computing

Research Technologies *Expert in* Python, Numpy, Scipy, F2py, Fortran, Matplotlib, Bash, PPSS, Latex, Gnuplot, HTML5, PHP, MVC, OOP, JSON, CSS, XML, website construction & templating languages.

Other Technologies *Fluent with* Mathematica, Matlab, Android, C++, D3js, javascript, Git, SVN, jQuery, Google Protocol Buffers and MySQL.

Presentations

Invited Talks

06/2017 **FIRE**, *"Neutron-induced and β-delayed fission: the final moments of r-process nucleosynthesis"*, *LLNL*, invited talk.

06/2017 **LANL**, *"LANL nuclear reaction and structure models: recent applications and insights"*, *Los Alamos, NM*, invited talk.

04/2017 **JINA-CEE**, *"Reverse engineering nuclear properties from r-process abundances"*, *online seminar*, invited talk.

12/2016 **FIRE**, *"Neutron-induced and β-delayed fission in the r-process"*, *Notre Dame, IN*, invited talk.

10/2016 **TRIUMF**, *"Nuclear physics for the rapid neutron capture process"*, *Vancouver, Canada*, invited talk.

09/2016 **ND2016**, *"A new model for β-delayed neutron emission and applications to the astrophysical r process of nucleosynthesis"*, *Brugges, Belgium*, invited talk.

06/2016 **ICNT**, *"The r-process and sensitivities to nuclear physics"*, *East Lansing, MI*, invited talk.

07/2015 **CETUP***, *"Nuclear physics uncertainties and the r process"*, *Deadwood, SD*, invited talk.

04/2015 **April APS**, *"Nuclear data sensitivities and the rapid neutron capture process"*, *Baltimore, MD*, invited talk.

01/2015 **LANL**, *"Towards a toolkit for nuclear astrophysics research"*, *LANL Los Alamos, NM*, invited talk.

09/2014 **FAIRNESS**, *"A primer on nucleosynthesis"*, *Italy*, invited talk.

08/2014 **CGS15**, *"Sensitivity of the r-process to nuclear physics inputs"*, *Germany*, invited talk.

06/2014 **RIBSS Retreat**, *"Sensitivity of the r-Process to Nuclear Physics Inputs"*, *East Lansing, MI*, invited talk.

05/2014 **ATLAS UGM**, *"Recent r-Process Sensitivity Studies"*, *Chicago, IL*, invited talk.

04/2014 **DOE-TC2014**, *"Nuclear Masses Near N=82 and Their Effects on r-Process Abundances"*, *Raleigh, NC*, invited talk.

04/2014 **CW2014**, *"Sensitivity of a Main r-Process to Nuclear Masses"*, *Santa Fe, NM*, invited talk.

09/2013 **LANL Data Group Seminar**, *"A New JINA Nuclide Database"*, *LANL Los Alamos, NM*, invited talk.

09/2013 **LANL Astrophysics Seminar**, *"Nuclear Masses Near N=82 and Their Effects on r-Process Abundances"*, *LANL Los Alamos, NM*, invited talk.

05/2012 **MSU Theory Seminar**, *"The Rare Earth Peak: An Overlooked r-Process Diagnostic"*, *MSU East Lansing, MI*, invited talk.

05/2012 **Notre Dame Nuclear Seminar**, *"The Rare Earth Peak: An Overlooked r-Process Diagnostic"*, *Notre Dame, IN*, invited talk.

Contributed Talks

11/2016 **IFCN6**, *"Properties of neutron-rich nuclei in the macroscopic-microscopic framework"*, *Sanibel Island, Florida*, contributed.

10/2016 **Fall DNP**, *"Beta-delayed neutron emission with neutron-gamma competition"*, *Vancouver, Canada*, contributed.

06/2016 **NIC2016**, *"The rare earth peak and the astrophysical location of the r-process"*, *Niigata, Japan*, contributed.

10/2015 **Fall DNP**, *"Global Monte Carlo calculations for r process nucleosynthesis"*, *Santa Fe, NM*, contributed.

03/2015 **JINA-CEE Frontiers**, *"Resolving the site(s) of the astrophysical r process"*, *East Lansing, MI*, speaker.

02/2015 **Group Seminar**, *"A quick primer on β-delayed neutron emission"*, *Notre Dame, IN*, seminar speaker.

10/2014 **DNP**, *"New calculations of β-delayed neutron emission probabilities"*, *Hawaii*, contributed talk.

08/2014 **INT2014**, *"Impact of nuclear physics inputs on the freeze-out phase of the r-process"*, *Seattle, WA*, seminar speaker.

07/2014 **NIC2014**, *"Impact of nuclear masses near closed shells on r-process abundances"*, *Hungary*, contributed talk.

10/2013 **Fall DNP 2013**, *"Nuclear Masses Near N=82 and Their Effects on r-Process Abundances"*, *Newport News, VA*, contributed talk.

09/2013 **Mazurian Lakes**, *"Nuclear Data Sensitivities for r-Process Nucleosynthesis"*, *Piaski, Poland*, speaker.

06/2013 **GRC 2013**, *"Nuclear Masses Near N=82 and Their Effects on r-Process Abundances"*, *New London, NH*, poster session.

04/2013 **Notre Dame Nuclear Seminar**, *"The Role of Nuclear Physics in the r-Process"*, *Notre Dame, IN*, seminar speaker.

11/2012 **NAVI-JINA Meeting**, *Late-time Dynamics And Impliciations For r-Process Nucleosynthesis"*, *NSCL East Lansing, MI*, speaker.

10/2012 **JINA Frontiers Meeting**, *"The Rare Earth Peak: An Overlooked r-Process Diagnostic"*, *MSU East Lansing, MI*, speaker.

08/2012 **NIC XII r-Process Workshop**, *"The Rare Earth Peak: An Overlooked r-Process Diagnostic"*, *Cairns, Australia*, speaker.

01/2012 **LANL Astrophysics Seminar**, *"The Formation Of The Rare Earth Elements: A Tool For Understanding The Site Of The r-Process"*, *LANL Los Alamos, NM*, seminar speaker.

10/2011 **Fall DNP 2011**, *"Formation Of The Rare Earth Peak: Gaining Insight Into Late-Time r-Process Dynamics"*, *MSU East Lansing, MI*, contributed talk.

10/2011 **NCSU Astrophysics Journal Club**, *"Formation Of The Rare Earth Peak: Gaining Insight Into Late-Time r-Process Dynamics"*, *NCSU Raleigh, NC*, speaker.

06/2011 **NNPSS 2011**, *"A New Production Mechanism For The Rare Earth Peak"*, *UNC Chapel Hill, NC*, poster session.

04/2011 **DOE Review Talk**, *"Rare Earth Isotopes And The r-Process"*, *NCSU Raleigh, NC*, speaker.

04/2011 **Reaction Network School**, *"Nova Nucleosynthesis"*, *Chiemsee, Germany*, speaker.

07/2010 **NIC-XI 2010**, *"Neutron Capture Rates And The Rare Earth Peak"*, *Heidelberg, Germany*, poster session.

07/2009 **Connecting Quarks & Cosmos**, *"The Influence Of Neutron Capture Rates In The Rare Earth Region Of The r-Process Abundance Pattern"*, *INT Seattle, WA*, contributed talk.

10/2008 **SESAPS 2008**, *"The Influence Of Neutron Capture Rates In The Rare Earth Region On The r-Process"*, *Raleigh, NC*, contributed talk.

09/2008 **NCSU Astrophysics Journal Club**, *"The Influence of Neutron Capture Rates In The Rare Earth Region On The r-Process"*, *NCSU Raleigh, NC*, speaker.

Papers In Preparation

[1] **M. Mumpower**, T. Kawano, P. Möller, "Neutron-induced fission with neutron-gamma competition", In preparation (2017).

[2] **M. Mumpower**, T. Kawano, P. Möller, "β-delayed fission in the coupled QRPA+HF approach", In preparation (2017).

[3] **M. Mumpower**, T. Kawano, J. L. Ullmann, M. Krtička, T. M. Sprouse, "Estimation of M1 scissors mode strength for deformed nuclei in the medium to heavy mass region by statistical Hauser-Feshbach model calculations in the fast energy range", In preparation (2017).

Refereed Papers

[1] A. Spyrou, et al., "Neutron-capture rates for explosive nucleosynthesis: the case of ^{68}Ni$(n,\gamma)^{69}$Ni", J. Phys. G 44 4 044002 (2017).

[2] **M. Mumpower**, G. C. McLaughlin, R. Surman, A. W. Steiner, "Reverse engineering nuclear properties from rare earth abundances in the r process", J. Phys. G 44 3 034003 (2017).

[3] **M. Mumpower**, G. C. McLaughlin, R. Surman, A. W. Steiner, "The link between rare earth peak formation and the astrophysical site of the r process", ApJ 833, 282 (2016).

[4] **M. Mumpower**, T. Kawano, P. Möller, "Neutron-gamma competition for β-delayed neutron emission", Phys. Rev. C 94 064317 (2016).

[5] T. Shafer, J. Engel, C. Fröhlich, G. C. McLaughlin, **M. Mumpower**, R. Surman, "Beta decay of deformed r-process nuclei near $A \sim 80$ and $A \sim 160$, including odd-A and odd-odd nuclei, with the Skyrme finite-amplitude method", Phys. Rev. C 94 055802 (2016).

[6] A. Spyrou, et al., "Strong neutron-γ competition above the neutron threshold in the decay of ^{70}Co", PRL 117, 142701 (2016).

[7] S. Liddick, et al., "Experimental neutron capture rate constraint far from stability", PRL 116, 242502 (2016).

[8] **M. Mumpower**, G. C. McLaughlin, R. Surman, A. Aprahamian, "The impact of individual nuclear properties on r-process nucleosynthesis", Progress in Particle & Nuclear Physics 86 86-126 (2016).

[9] **M. Mumpower**, R. Surman, D. L. Fang, M. Beard, P. Möller, T. Kawano, A. Aprahamian, "The impact of individual nuclear masses on r-process abundances", Phys. Rev. C 92 035807 (2015).

[10] P. Möller, A. J. Sierk, T. Ichikawa, A. Iwamoto, **M. Mumpower**, "Fission Barriers at the End of the Chart of Nuclides", Phys. Rev. C 91 024310 (2015).

[11] **M. Mumpower**, R. Surman, D. L. Fang, M. Beard, A. Aprahamian, "The impact of uncertain nuclear masses near closed shells on the r-process abundance pattern", J. Phys. G 42 034027 (2015).

[12] **M. Mumpower**, D. L. Fang, R. Surman, M. Beard, A. Aprahamian, "The impact of nuclear masses near $N = 82$ on r-process abundances", arXiv:1411.3978 (2014).

[13] A. Aprahamian, I. Bentley, **M. Mumpower**, R. Surman, "Sensitivity studies for a main r process: nuclear masses", AIP Advances 4, 041101 (2014).

[14] **M. Mumpower**, J. Cass, G. Passucci, R. Surman, A. Aprahamian, "Sensitivity studies for a main r process: β-decay rates", AIP Advances 4, 041009 (2014).

[15] R. Surman, **M. Mumpower**, R. Sinclair, K. Jones, W. Hix, G. McLaughlin, "Sensitivity studies for a weak r process: neutron capture rates", AIP Advances 4, 041008 (2014).

[16] **M. Mumpower**, G. McLaughlin, R. Surman, "The Influence of Neutron Capture Rates In The Rare Earth Region Of The r-Process Nucleosynthesis", Phys. Rev. C, 86 035803 (2012).

[17] **M. Mumpower**, G. McLaughlin, R. Surman, "The Rare Earth Peak: An Overlooked r-Process Diagnostic", ApJ, 752, 117 (2012).

[18] **M. Mumpower**, G. McLaughlin, R. Surman, "Formation of the rare earth peak: gaining insight into late-time r-process dynamics", Phys. Rev. C, 85 045801 (2012).

Refereed Conference Proceedings

[1] T. Kawano, **M. Mumpower**, "Enhancement of neutron capture rates for deformed nuclei and impact on r-process nucleosynthesis calculations", 011003 JPSCP NIC2016.

[2] R. Surman, **M. Mumpower**, G. C. McLaughlin, A. Aprahamian, "Systematic and statistical uncertainties in simulated r-process abundances due to uncertain nuclear masses", 010612 JPSCP NIC2016.

[3] **M. Mumpower**, G. C. McLaughlin, R. Surman, , A. W. Steiner, "The Rare earth peak and the astrophysical location of the r prorcess", 020614 JPSCP NIC2016.

[4] R. Surman, **M. Mumpower**, A. Aprahamian, "Uncorrelated nuclear mass uncertainties and r-process abundance predictions", Mazurian Lakes (Submitted 2015).

[5] **M. Mumpower**, R. Surman, A. Aprahamian, "Variances in r-process predictions from uncertain nuclear rates", FAIRNESS (2014).

[6] **M. Mumpower**, R. Surman, A. Aprahamian, "The impact of global nuclear mass model uncertainties on r-process abundance predictions", CGS15 (2014).

[7] S. Frauendorf, M. Beard, **M. Mumpower**, R. Schwengner, K. Wimmer, "Low-energy magnetic radiation", CGS15 (2014).

[8] **M. Mumpower**, R. Surman, A. Aprahamian, "Nuclear masses near $N = 82$ that influence r-process abundances", NIC XIII (2014).

[9] R. Surman, **M. Mumpower**, A. Aprahamian, "The sensitivity of r-process nucleosynthesis to individual β-delayed neutron emission probabilities", ARIS (2014).

[10] R. Surman, **M. Mumpower**, J. Cass, A. Aprahamian, "The sensitivity studies for r-process nucleosynthesis in three astrophysical scenarios", INPC (2013).

[11] R. Surman, **M. Mumpower**, J. Cass, A. Aprahamian, "The sensitivity of r-process nucleosynthesis to the properties of neutron-rich nuclei", ICFN5 (2013).

[12] R. Surman, G. McLaughlin, **M. Mumpower**, W. Hix, K. Jones, R. Sinclair, "Neutron Captures and the r-process nucleosynthesis", CGS14 (2012).

[13] **M. Mumpower**, R. Surman, G. McLaughlin, "The rare earth peak: a new r-process diagnostic", Proceedings of Science, NIC-XII (2012).

[14] **M. Mumpower**, R. Surman, G. McLaughlin, "Neutron Captures And The Rare Earth Peak", Proceedings of Science, NIC-XI 273 (2010).

[15] R. Surman, G. McLaughlin, **M. Mumpower**, W. Hix, K. Jones, "Neutron Capture In The r-Process", Proceedings of Science, NIC-XI 284 (2010).

References

[1] **Professor** Ani Aprahamian
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[2] **Professor** Gail McLaughlin (thesis advisor)
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[3] **Professor** Rebecca Surman
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