Brian O'Shea

Associate Professor, CMSE; Department of Physics and Astronomy
oshea@msu.edu | 517.884.5638 | 567 Wilson Rd., Room 3258

BIO SKETCH

Brian O'Shea joined the Michigan State University faculty in 2008, and is an associate professor with a joint appointment in the Department of Computational Mathematics, Science and Engineering; the Department of Physics and Astronomy; and the National Superconducting Cyclotron Laboratory. He is also a member of the Joint Institute for Nuclear Astrophysics, the Michigan Institute for Plasma Science and Engineering, and the Great Lakes Consortium for Petascale Computation.

Dr. O'Shea is a computational and theoretical astrophysicist studying cosmological structure formation, including galaxy formation and the behavior of the hot, diffuse plasma within galaxy clusters. He is also a co-author of the Enzo AMR code, an expert in high performance computing, and an advocate for open-source computing and open-source science. He has authored or co-authored more than 50 peer-reviewed journal articles in astrophysics, computer science and education research journals.

He received his B.S. in engineering physics at the University of Illinois in Urbana-Champaign (UIUC) in 2000, and his Ph.D. in physics from UIUC in 2005 (with 2002–2005 being spent as a graduate student in residence at the Laboratory for Computational Astrophysics at UC San Diego and in the Theoretical Astrophysics Group at Los Alamos National Laboratory). Following that, he was a Director's Postdoctoral Fellow at Los Alamos National Laboratory, with a joint appointment between the Theoretical Astrophysics Group and the Applied Physics Division.

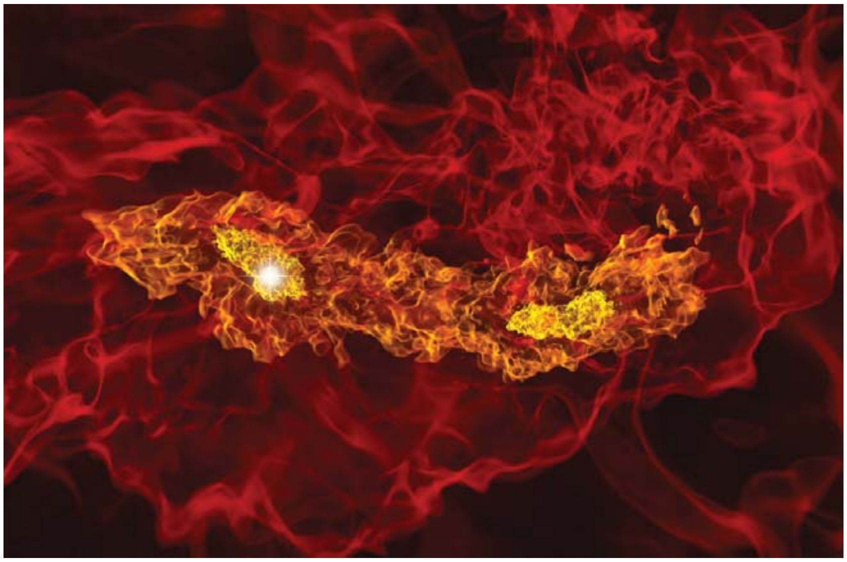

FIGURE 1. This image is a volume rendering from a large-scale simulation of the formation of the first galaxies, carried out on the NSF's Blue Waters supercomputer. In this image, the field of view is approximately 5,000 light-years across and shows both stars (bright white points) and emission from hot plasma (diffuse blue and orange) that is being heated by ultraviolet light from nearby massive stars. This galaxy is only a few hundred million years old—a few percent of the current age of the universe—and is only 0.1% of the mass of the Milky Way. By the time it evolves to the present day, more than 13 billion years later, it will be even larger than the Milky Way galaxy.

RESEARCH INTERESTS

Cosmological structure formation, including galaxies and the intergalactic medium over the age of the universe; algorithms for massively parallel computing; physics and computational science education

LAB(S)/GROUP(S)

National Superconducting Cyclotron Laboratory; Great Lakes Consortium for Petascale Computing; Michigan Institute for Plasma Science and Engineering

WEBSITE

http://www.pa.msu.edu/~oshea/

GROUP MEMBERS

POSTDOCTORAL RESEARCHERS: Benoit Cote (P&A; NSCL), Devin Silvia (P&A; NSF Fellow), Brian Danielak (CMSE). GRADUATE STUDENTS: Brian Crosby, Greg Meece, Austin Edmister. UNDERGRADUATE STUDENTS: Madison Fitzgerald, Larissa Kennerley, Claire Kopenhafer, Alex Kreger, Yuanxio Jia.

CURRENT RESEARCH FOCUS

My research focuses on theoretical and numerical studies of galaxy formation and evolution, primarily through the use of large-scale numerical simulations. I am also interested in the development of algorithms and numerical tools for massively parallel computing, and in research relating to physics and computational science education. Some specific interests are:

Formation of the first galaxies. The first stars and galaxies are important because they set the stage for all later structure formation in the universe, by seeding radiation, metal-enriched gas, and black holes. My group focuses on radiation hydrodynamical studies of the earliest galaxies in order to interpret observations made by the Hubble Space Telescope and to make predictions for the upcoming James Webb Space Telescope.

Milky Way–like galaxies and the intergalactic medium. Galaxies are composed of vastly more than the stars that are easily seen with optical telescopes. Galaxies like our own Milky Way are surrounded by halos of plasma that serve as a reservoir of gas for star formation and as a repository for gas being ejected from galaxies by supernovae and supermassive black hole feedback. My group focuses on studying the interplay between the circumgalactic and intergalactic plasma and the stellar populations of the galaxies, and in addition seeks to build statistical tools to both compare to large-scale astronomical

FIGURE 2. This image is a volume rendering from a simulation of the formation of a binary Population III stellar system. Population III stars are the first stars to form in the universe, and contribute to the formation of galaxies like our own Milky Way. In this image, the field of view is about 2,000 astronomical units across (one astronomical unit is the distance between the Earth and the Sun, or about 93 million miles). The two yellow clumps are the gas clouds in which the two stars are being born.

surveys and to quantify uncertainties associated with modern techniques for studying galaxy formation.

Galaxy clusters. Composed of tens or hundreds of galaxies orbiting within a single common dark matter halo, galaxy clusters are the largest gravitationally-bound structures in the universe. As a result, galaxy clusters are both useful probes of cosmology (in particular, the properties of dark matter and dark energy) and of plasma physics in extreme physical conditions. My group's research focuses on the effects of non-thermal physics (magnetic fields, cosmic rays, supermassive black hole feedback) on the intracluster plasma, as well as alternative methods for simulating galaxies within clusters.

Computational science education. The ability to make models of systems—physical, biological, financial, social, or otherwise—is a critical skill that is widely used in the sciences, engineering, and in business. Similarly, the ability to manipulate and visualize data is critical. However, most students learn how to do these things informally, which often means that they have critical gaps in their understanding of model-making and data manipulation. My group's focus is on how students learn to think about and make models, student identity relating to computational science, and active learning techniques in computational science.

RECENT PUBLICATIONS

B.D. Smith, J.H. Wise, B.W. O'Shea, M.L. Norman, S. Khochfar, "The first Population II stars formed in externally enriched mini-haloes," *Monthly Notices of the Royal Astronomical Society*, 452, 2822–2836 (2015) (ADS link).

G.R. Meece, B.W. O'Shea, G.M. Voit, "Growth and evolution of thermal instabilities in idealized galaxy cluster cores," *The Astrophysical Journal*, 808, 43 (2015) (ADS link).

B.W. O'Shea, J.H. Wise, H. Xu, M.L. Norman, "Probing the ultraviolet luminosity function of the earliest galaxies with the Renaissance Simulations," *The Astrophysical Journal Letters*, 807, L12 (2015) (ADS link).

G.M. Voit, G.L. Bryan, B.W. O'Shea, M. Donahue, "Precipitation-regulated star formation in galaxies," *The Astrophysical Journal Letters*, 808, 30 (2015) (ADS link).

G.L. Bryan, M.L. Norman, B.W. O'Shea et al. (28 co-authors total), "ENZO: An adaptive mesh refinement code for astrophysics," *The Astrophysical Journal Supplement*, 211, 19 (2014) (ADS link).