New Faculty

(APRIL 2007)

Sara Seager

Associate Professor of Physics, Division of Astrophysics; and Ellen Swallow Richards Associate Professor of Earth, Atmospheric and Planetary Sciences

RESEARCH INTERESTS

Sara Seager's current research interests are focused upon extrasolar planet atmospheres and interiors. Over 200 exoplanets are known to orbit nearby stars. Now that their existence is firmly established, a new era of exoplanet characterization has begun. A subset of exoplanets, called transiting planets, pass in front of and behind their stars, as seen from Earth. Transiting planets have immeasurably changed the field of exoplanets because their physical properties, including average density and atmospheric thermal emission, can be now be routinely measured. Seager's group aims to understand the atmospheric composition and the interior structure of exoplanets, with a focus on the new and growing data set of transiting exoplanets.

BIOGRAPHICAL SKETCH

Sara Seager received her B.Sc. in mathematics and physics from the University of Toronto in 1994. She earned a Ph.D. in astronomy from Harvard University in 1999, where she investigated recombination in the early Universe before moving to the then brand-new field of exoplanets. Seager was a long-term member at the Institute for Advanced Study in Princeton, NJ, and a senior research staff member at the Carnegie Institution of Washington in Washington, D.C., before joining the MIT faculty in 2007. Seager was awarded the American Astronomical Society's Helen B. Warner prize in 2007 for her work on extrasolar planet atmospheres.

Donna Coveney/MIT

For a list of Prof. Seager's selected publications, please visit her faculty web page at web.mit.edu/physics/facultyandstaff/index.html.

(JULY 2007)

Martin Zwierlein

Assistant Professor of Physics, Division of Atomic, Biological, Condensed Matter and Plasma Physics

RESEARCH INTERESTS

Martin Zwierlein's research focuses on ultracold quantum gases of atoms and molecules. Just a few billionths of a degree above absolute zero and a million times thinner than air, these gases provide ideal model systems for many-body physics in a clean and controllable environment.

Greg Hren Photography

After the realization of Bose-Einstein condensation (BEC) in dilute bosonic gases in 1995, the observation of superfluidity in Fermi gases became a long-standing goal in the field of ultracold atoms. Together with his colleagues at MIT, Zwierlein observed BEC of pairs of fermionic lithium atoms in 2003. With the help of Feshbach resonances, interactions between fermions could be tuned at will; this enabled Zwierlein to access the crossover from a BEC of molecules to a Bardeen-Cooper-Schrieffer (BCS) state of long-range pairs. Superfluidity was demonstrated in 2005 by setting the strongly interacting Fermi gas in rotation and observing an ordered lattice of quantized vortices. Scaled to the density of electrons in a metal, this form of superfluidity would occur already far above room temperature.

Zwierlein and colleagues moved on to address an old question on the ground state of imbalanced fermionic mixtures, wherein not every "spin up" fermion can find a "spin down" partner. At a critical spin imbalance—the Clogston-Chandrasekhar limit observed by Zwierlein—the superfluid state is destroyed and a strongly interacting Fermi mixture remains.

More recently, Zwierlein worked on an experiment on fermions and bosons in optical lattices at the University of Mainz. Fermi mixtures with repulsive interactions, confined to an optical lattice, might enable the simulation of an important model in the context of high-temperature superconductors, the fermionic Hubbard model.

Currently, Zwierlein is investigating ultracold mixtures of different fermionic species. An equal mixture of fermionic lithium-6 and potassium-40 atoms would constitute a fermionic superfluid in which the pairing partners are not related to each other by time-reversal symmetry. In their vibrational ground state, heteronuclear LiK molecules would possess a large electric dipole moment, opening up possibilities to study quantum gases with anisotropic long-range interactions.

Fermi mixtures involving more than one spin state per atomic species can serve as a rudimentary model system of exotic matter, such as quark ("color") superfluids in the core of neutron stars.

BIOGRAPHICAL SKETCH

Martin Zwierlein studied physics at the University of Bonn and at the Ecole Normale Supérieure in Paris, where he received his undergraduate and master's degrees in theoretical physics in 2002. Later that year, he started his Ph.D. in experimental atomic physics in the group of Wolfgang Ketterle at MIT. His research focused on the observation of superfluidity in ultracold fermionic gases, a model system for strongly interacting matter. After a postdoctoral stay at the University of Mainz in the group of Immanuel Bloch, Martin rejoined the MIT community as an assistant professor of physics in July 2007.

For a list of Prof. Zwierlein's selected publications, please visit his faculty web page at web.mit.edu/physics/facultyandstaff/index.html.