# Basic Physics with Exotic Millisecond Pulsars

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pler. Using this framework we find that the most common planet inside the snowline scales with the mass of the central star and it is ∼3–10 times less massive than the one outside, as identified via microlensing. By extending the Kepler statistics with RV data, we also find evidence for a drop in the giant planet occurrence rate beyond the snowline. We conclude by discussing the implications of these results on future missions.

### 227.06 — The WFIRST Exoplanet Microlensing Survey: Core Science Goals and Predicted Yields

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One of WFIRST's primary mission goals is to conduct an exoplanet microlensing survey in the Galactic bulge. The survey will provide a statistical assay of the cold exoplanet population with masses greater than that of Mars and orbits beyond 1 AU, with a total planet yield comparable to Kepler's. It will also measure the mass function of free-floating planets potentially down into the mass regime of large Kuiper Belt Objects. The WFIRST microlensing survey parameter space spans critical mass and distance scales in planet formation theories, including the ice line, the isolation mass, and the critical mass for runaway gas accretion. I will give an overview of the WFIRST microlensing survey, and highlights of its expected results.

### 227.07 — Mu and You: Public Microlensing Analysis Tools and Survey Data

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In the era of big survey astronomy, microlensing is becoming increasingly more accessible to astronomers with a wide variety of backgrounds and expertise. With the advent of public analysis tools, publicly available data, and a multi-tiered data challenge, it is now possible for any interested scientist to find, analyze, and derive physical properties for microlensing events. This is accomplished via a coder's choice of open source microlensing modeling codes, including MuLensModel, PyLIMA, MuLAN, and VBBinaryLensing. These public software tools allow users to fit microlensing light curves and derive the physical quantities of lens systems. These analysis codes are complemented by the release of the first public microlensing survey data sets. In particular, all data from the near-infrared and ongoing UKIRT microlensing survey of the Galactic bulge spanning 2015-2018 are now publicly available via the NASA Exoplanet Archive. Finally, as part of the 2018 Microlensing Data Science challenge, a Jupyter notebook has been created to facilitate interaction with MuLensModel, PyLIMA, and MuLAN in a user-friendly python-based package. The goal of this challenge is to increase the number and diversity of experts to the field of gravitational microlensing, and to recruit scientists with fresh ideas in anticipation of and preparation for *WFIRST*.

## 228 — Frontiers of Pulsar Astrophysics

### 228.01 — Illuminating a New Population of Rotation-Powered Pulsars

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The launch of the Fermi Gamma-ray Space Telescope in 2008 provided pulsar astronomers a powerful tool in their hunt for new pulsars. Now, a decade later, we can see how the pulsar population landscape has been changed. The past ten years have witnessed dedicated partnerships of gamma-ray researchers with radio pulsar astronomers, leading to the discovery of several unexpected new classes of pulsars. In addition, powerful new computing algorithms have unveiled many more pulsars not seen outside the gamma-ray regime. We discuss these discoveries, and how regular monitoring of the gamma-ray sky has changed our understanding of both the physics of pulsars and their intrinsic populations.

### 228.02 — Basic Physics with Exotic Millisecond Pulsars

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Some of the highest profile, and highest impact, results from pulsar timing involve probing the high-density physics at the cores of the neutron stars or testing general relativity in new and better ways. These efforts almost always involve the rarest and most exotic of recycled binary systems, including those which formed in unusual ways, or those whose orbits or companions were altered later, as often happens in globular clusters. We report recent results, using timing and search observations from the GBT and Arecibo, on several of these exotic systems. We have new and potentially exciting neutron star mass measurements and new tests of general relativity. And we suggest that it is well worth the efforts involved to uncover and examine these "1%" pulsar systems.

### 228.03 — Testing General Relativity Using a Pulsar in a Triple System

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The millisecond pulsar PSR J0337+1715 is in a 1.6-day orbit with an inner white dwarf companion, and the pair is in a 327-day orbit with an outer white dwarf companion. This hierarchical triple provides an excellent laboratory to test a key idea of Einstein's theory of gravity, the strong equivalence principle (SEP): do all objects, even those with strong gravity like neutron stars, fall the same way in the same gravitational field? Almost all alternative theories of gravity predict violations of the SEP at some level. We have carried out an intensive program of timing this pulsar, and we are able to perform a very sensitive test of the SEP. I will discuss our methods, our result, and its theoretical implications.

### 228.04 — The NANOGrav 11-year Data Set: New Insights into Galaxy Growth and Evolution

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The NANOGrav collaboration monitors an array of over 70 precisely timed millisecond pulsars with the Green Bank Telescope and Arecibo Observatory in order to detect perturbations due to gravitational waves at nanohertz frequencies. These gravitational waves will most likely result from an ensemble of supermassive black hole binaries. I will present the most recent upper limits on various types of gravitational wave sources and will demonstrate that these limits are already constraining models for galaxy formation and evolution. I will then describe the dramatic gains in sensitivity that are expected from discoveries of millisecond pulsars, more sensitive instrumentation, improved detection algorithms, and international collaboration and show that detection is possible before the end of the decade.

### 228.05 — Current results and future prospects from PSR J1757-1854, a highly-relativistic double neutron star binary.

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