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The End of Accretion: The X-Ray Binary/Millisecond Pulsar Transition Object PSR J1023+0038

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Millisecond radio pulsars (MSRPs), those spinning hundreds of times per second, have long been understood to be old pulsars that have been spun up by the accretion of matter from a companion in a low-mass X-ray binary (LMXB) phase. Yet the details of this transformation, particularly the end of the accretion process and the birth of a radio pulsar, remain mysterious. I will describe the discovery and detailed study of the first object known to transition between MSRP and LMXB states, PSR J1023+0038. By dint of a multiwavelength campaign of observations in the RMSP state, we are able to measure all the key system parameters and show the existence of an X-ray shock close to the pulsar-facing side of the companion. Since the discovery of PSR J1023+0038, two more objects (XSS J12270-4859 and M28I) have been found to make the same transition, and the study of these transitioning objects has become an active field of research. Most interestingly, PSR J1023+0038 has transitioned back into an LMXB state, with an active accretion disk and a puzzling increase in gamma-ray flux. Our detailed picture of the system allows us to test models of accretion against the phenomena we observe in PSR J1023+0038, and in fact these observations challenge current models: in spite of the low luminosity of the system (and low inferred accretion rate) some material is penetrating the centrifugal barrier and falling on the neutron-star surface. Key evidence for explaining this puzzling behaviour will come when PSR J1023+0038 returns to an MSRP state and we are able to compare pulsar timing models from after the LMXB state with those we obtained in this work.