

“An X-Raydio Switcheroo” – The detection of correlated mode changes in radio and X-ray

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Abstract. We present high-sensitivity XMM/LOFAR observations that show for the first time that mode switching extends from radio to X-ray. In pulsar B0943+10, the known changes in radio profile and drift rate are confidently tied to simultaneous changes in X-ray emission.

In mode switching, seen in many pulsars, profile and subpulse-drift behavior change almost instantaneously. The mechanism for these drastic changes, or for the bi-stable emission behavior, is not understood; while even for the basic emission mechanism different families of theories (e.g. vacuum gap, or space-charge limited flow models) exist.

To discriminate between such models, we carried out a campaign of 42 hours of simultaneous LOFAR/XMM-Newton observations on PSR B0943+10. Through LOFAR's unparalleled low-frequency sensitivity, mode changes were pinpointed to 10-second accuracy. XMM X-ray photons were next separated by the two radio modes. We discovered large modal differences in the X-ray pulsations, flux, and spectral shapes: in the radio-bright mode, no X-ray pulsations are detected – but in the radio-quiet mode, B0943+10 is strongly pulsating in X-ray.