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Wavelet analyses of Saturn's rings: Extracting masses and motions from wavelet phases

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Wavelets are powerful tools for identifying and quantifying quasi-periodic patterns in data sets. Many analyses focus on the power in the wavelet, which quantifies the strength of any periodic signal as a function of position and frequency. However, it turns out that the phase of the wavelet transform can also be extremely useful for characterizing certain types of signals. This talk will present examples of how we have extracted interesting new information about Saturn's rings from wavelet phase analyses of quasi-periodic patterns known as density waves that are generated at specific ring locations by periodic forces. Many of these waves can be attributed to perturbations from Saturn's various moons, but analyses of the wavelet phases have allowed us to identify the frequency of the perturbing forces involved and demonstrate that certain waves are likely produced by normal-mode oscillations inside the planet itself. Elsewhere in the rings, wavelet phase information enables extremely weak wave signals to be identified in nearly opaque regions, yielding new estimates of the rings' surface mass density. These wavelet techniques are therefore providing new insights into the planet's internal structure and the rings' total mass.

In collaboration with Philip Nicholson and Matthew Tiscareno, Cornell University.