Contribution ID: **123** Type: **Oral presentation**

The power of the dark side: hunting spiders to find massive neutron stars

Tuesday 17 June 2025 14:30 (15 minutes)

What is the maximum mass of a neutron star, above which it collapses into a black hole? The answer to this seemingly simple question has far-reaching implications for nuclear physics, astrophysics, and the emerging field of gravitational wave astronomy. Despite its importance - particularly in determining the equation of state of ultra-dense matter - this crucial quantity is still poorly constrained.

Compact binary millisecond pulsars - nicknamed 'spiders' - consist of a rapidly-rotating neutron star in a tight orbit with a low-mass main-sequence companion. Thanks to the sustained accretion phase that spins up their pulsars, these systems provide a promising avenue for finding the most massive neutron stars. Unfortunately, weighing these systems is far from simple. Many spiders exhibit intense irradiation effects due to ablation of the companion by the pulsar's wind. This drastically alters the light from these systems, making obtaining robust masses challenging.

The dark side of the companion holds the key to accurate mass measurements in spiders. Using spectroscopic observations from the world's largest optical telescopes, we can resolve spectral features associated with different stellar temperatures - and thus different locations on the companion's surface - to both correct for, and leverage the effects of irradiation, to precisely trace the companion throughout its orbit.

In this talk, I will summarise the results of these deep spectroscopic studies from our group at NTNU. I will highlight some of our unique discoveries, while also showing how we use these results to constrain our models, and thus continue the hunt for the most massive neutron stars.

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Session Classification: Parallell A3