Modelling the Impact of Flares on Short-Period Brown Dwarfs

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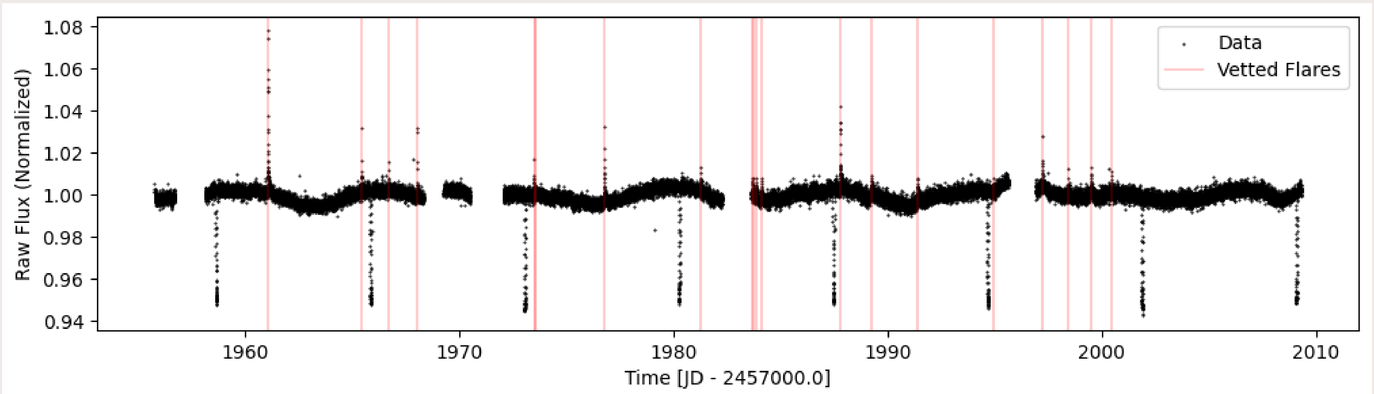
Question: What happens when superflares from M dwarfs impact close brown dwarf companions?

A number of brown dwarfs are now known on <10 day orbits around actively flaring M dwarfs

Their atmospheres are more readily observable than those of more common smaller planets

Most known M dwarfs hosting Jovian planets have infrequent flares



One example of a brown dwarf transiting an active M dwarf, as observed by *TESS.* Flares are marked by red vertical lines, all of which are >10^{32} erg, more energetic than the Carrington event.

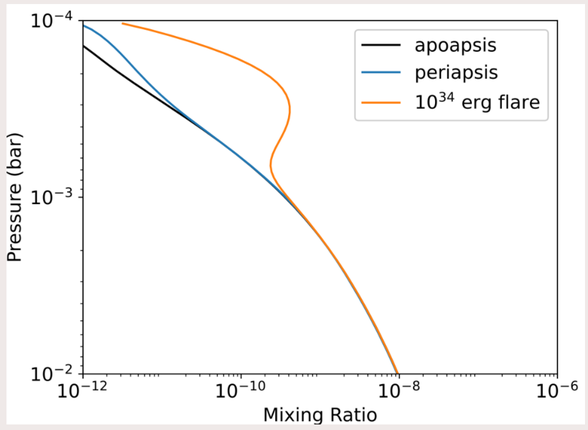
My work: Simulate the brown dwarf atmosphere's photochemical response to a flare and the observability of that response with high-resolution emission spectroscopy

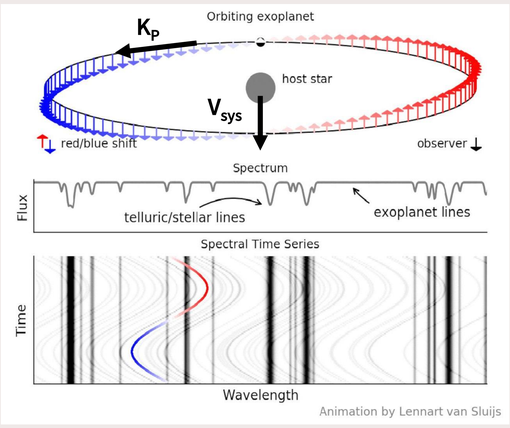
Previous studies in giant planets have identified CH_4, NH_3, C_2H_2, and HCN as photoreactive species – I am extending this work for higher gravities and higher temperature species appropriate for brown dwarfs

Changes in mixing ratio might be observable in high-resolution (R>20,000) cross-correlation spectroscopy

(Left) Sample response of TiO to a flare 100x more energetic than the Carrington event, compared to changes from moderate eccentricity

(Right) Cartoon diagram illustrating high-resolution cross-correlation spectroscopy

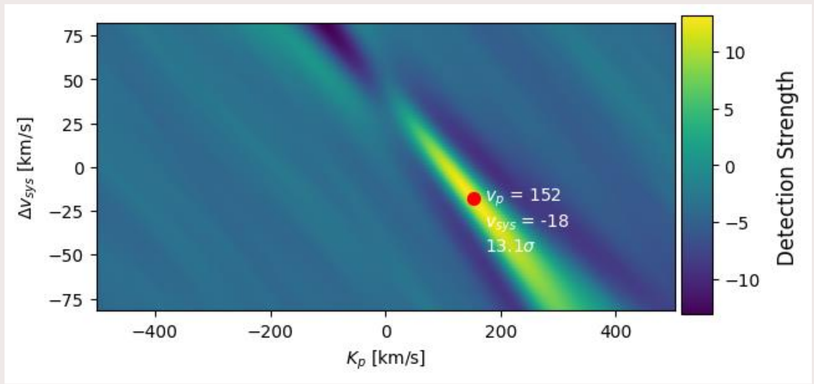




Why it's important: Brown dwarf or giant planet atmospheres could provide a context for real-time observation of flare-driven photochemistry, with implications for smaller, habitable planets as well

A single half-night of Keck/KPIC observations can produce a strong atmosphere detection, meaning we can look for day-to-day spectral variability and potentially correlate changes to individual flares

Success would provide valuable observational grounding for the study of flare-impacts in planetary atmospheres – it could also aid atmosphere simulations of terrestrial planets around flaring M dwarfs



Cross-correlation detection strengths as a function of system orbital velocity and brown dwarf Keplerian velocity (left) or frame-by-frame in a simulated observation (right)