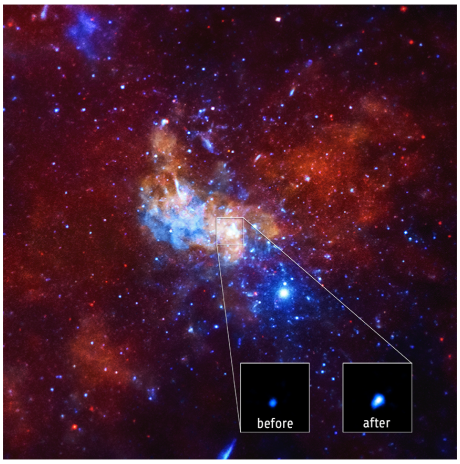
Non-thermal flares from Sgr A*



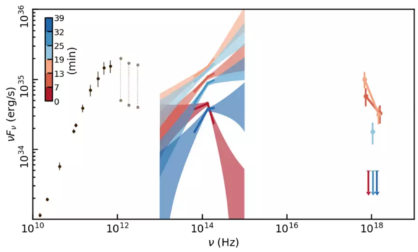
A synchrotron model for NIR/X-ray flares from Sgr A*

Sgr A is a million solar mass black hole at the center of our Galaxy that emits light over a wide range of frequencies. During its âĂIJquiescent state”, most of the radiation is emitted at sub-mm wavelengths, but during flares, the near-infrared (NIR) and X-ray fluxes increase significantly. Studying the spectra and light curves of the flaring emission can help us understand the radiative processes at play, and the properties of the accretion flow. This METEOR project includes (i) a detailed theoretical introduction on non-thermal radiative processes and properties of the accretion flow around Sgr A* , and (ii) an application NIR/X-ray flaring data.*

Theory

by Maria Petropoulou

Sgr A*, the supermassive black hole at the heart of the Milky Way, is a very faint source of electromagnetic radiation. The bolometric luminosity of Sgr A* is $L_{\rm bol} \sim 10^{36}$ erg s^{-1}, corresponding to an extremely low mass accretion rate, namely $\sim 10^{-8}\dot{M}_{\rm Edd}$ **[1]**. During “quiescence” the spectral energy distribution (SED) of Sgr A* is dominated by emission of thermal electrons in the accretion flow, which peaks at sub-mm wavelengths. Any X-ray emission produced via bremsstrahlung or other processes is very faint. However, during flares, Sgr A* “lights up” in near-infrared (NIR) wavelengths and X-rays. Flares are thought to be powered by synchrotron radiation of non-thermal electrons that are energized in a small region of the accretion flow. The fact that the fluxes can increase by a factor of ~ 10 over a short duration ($\sim$ 30min) suggests that the flares originate from the inner accretion flow ($\lesssim 10$ Schwarzschild radii). By studying the temporal evolution of the NIR/X-ray spectra of flares, as shown in the figure **[2]**, one can obtain important information about the properties of the flaring region of the accretion flow, such as magnetic field strength, and properties of the accelerated particles.



Applications

by Maria Petropoulou

1. The first practical module of the project will involve familiarisation of the student(s) with the numerical code `JetSet`[1] by looking into some test problems (e.g. calculation of synchrotron spectra from an evolving distribution of electrons). 2. The second practical module of the project will involve the modeling of NIR/X-ray data from recent Sgr A* flares. The student(s) will use light curves of flares to create a time series for the non-thermal electron luminosity. This will be then used as an input to the numerical code for the time-dependent calculation of the synchrotron spectra for various parameter values. The model spectra will be then compared to the data. For the latter, different statistical methods may be employed.

References

[1] Ponti et al. 2017, MNRAS, 468
[2] GRAVITY Collaboration, 2021, A&A, 654

Contact

☎ +302107276894 (supervisor)
✉ mpetropo@phys.uoa.gr

[1] `https://jetset.readthedocs.io/en/stable/index.html`