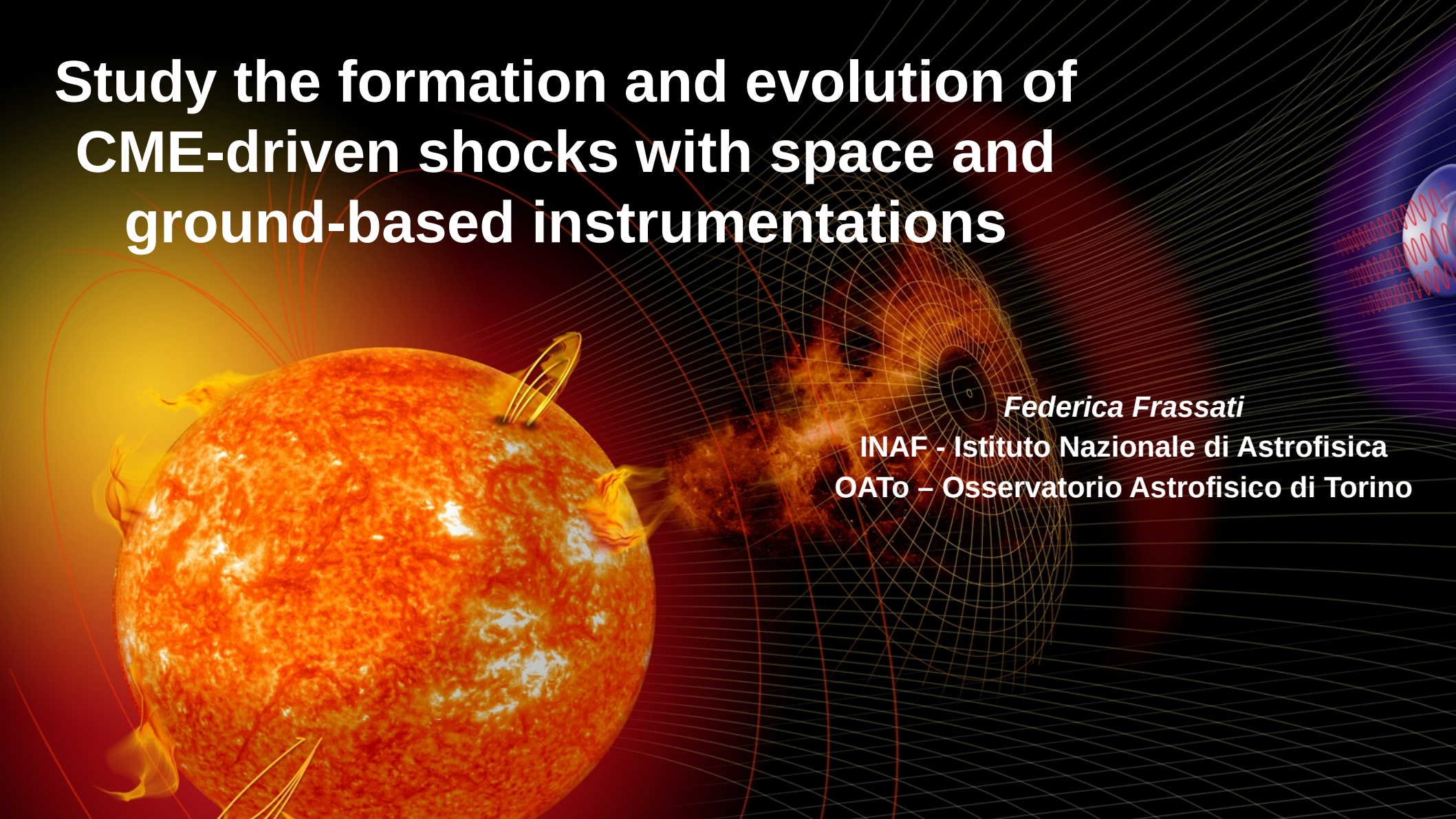
Study the formation and evolution of CME-driven shocks with space and ground-based instrumentations



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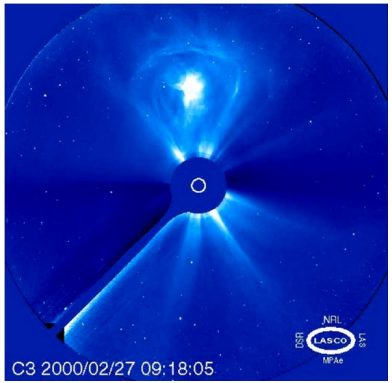
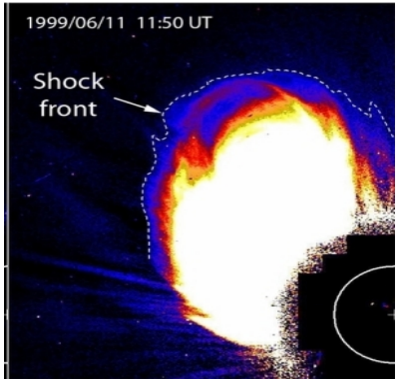
Solar transient phenomena: CME and Shocks

Many transient phenomena happen every day on Sun, including eruptions, flares, and coronal mass ejections (CMEs) that can drive interplanetary shocks and solar energetic particles (SEP events.

CMEs are expulsions of huge quantities of magnetized plasma (masses up to 10^{16} g) with speeds from 500 km/s up to 2500 km/s and dragging an expanding magnetic field and propagate from the Sun into the heliosphere;



A **shock** is formed in a medium when its main parameters (density, temperature, pressure, and velocity) suffer a discontinuity. When the CME speed > sound speed, a shock can be formed.



Why is it important to study CME-driven shocks?

The study of Shocks (origin and evolution) associated with major solar eruptions continues to be a very **important topic in Solar Physics**.

Scientific reasons (examples):
- to understand the dynamics of solar eruptions;
- to provide a better understanding of fundamental plasma physical processes (as plasma heating, acceleration of energetic particles at collisionless shock waves, …).

Technological and Biological reasons (examples):
- Energetic particles produced in the solar corona and propagating in the solar wind and toward the Earth, often generate significant radiation hazards, a major threat for spacecraft operations, technological systems, and astronauts.

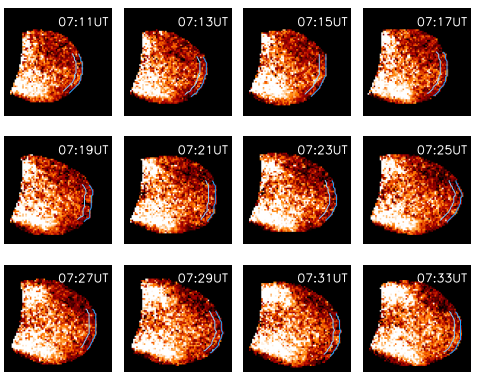
Understanding the origin, propagation and physical properties of **coronal shocks is crucial** to improve our scientific **knowledge** and therefore for possible applications to **Space Weather** services.

Work in progress:

“Study of plasma heating processes in a CME-driven shock sheath region observed with Metis coronagraph” (to be submitted to ApJL by December 2023)

Short Abstract - On 2021 September 28, a C1.6 class flare occurred in active region NOAA 12871 (S27W51). The flare was followed by a partial halo coronal mass ejection that caused the deflection of pre-existing coronal streamer structures, as observed in white-light coronagraphic images. A Type II radio burst was also detected by both space- and ground-based instruments, indicating the presence of a coronal shock propagating into interplanetary space.

By using Ultra Violet (Lyman - α) observations from the Metis coronagraph on-board the Solar Orbiter mission, we demonstrate, for the first, time the capability of UV imaging to provide, via a Doppler dimming technique, an upper limit estimate of the 2D distribution of the proton kinetic temperature in the CME-driven shock sheath as it passes through the field of view of the instrument.



Conferences :

- **SoHe 2023 - Fourth Meeting of the Italian Solar and Heliospheric Community**, Florence (Italy) 25-27/10/2023 (oral - attended)

- **European Space Weather Week 2023 (ESWW2023)**, Toulouse (France) – 20-24/11/2023
(poster – to be attended)

Future Work / Conferences:

Validate/improve the results obtained in “Study of plasma heating processes in a CME-driven shock sheath region observed with Metis coronagraph” by using different instrumentation (different wavelenghts) → production of one paper

Partecipation to **9th Metis Workshop** (Catania, 24 – 26 /01/2024)