



Observing the Mars aurorae with M-MATISSE and the Mars Aurora and dust Camera (M-AC)

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Mars Express revealed that ultraviolet aurorae could occur in the Mars atmosphere, despite lacking a global magnetic field. Then, MAVEN discovered that these aurorae are much more frequent than expected with Mars Express. MAVEN showed that these ultraviolet aurorae could either be localized and caused by electrons or, sometimes, much wider and due to proton precipitations related to SEP events. Aurorae have also been observed by MAVEN in regions without any crustal magnetic field. More recently, EMM captured stunning synoptic views of the Mars nightside in the UV and EUV, showing that auroral features can occur everywhere on the planet, at any time, and are highly variable in time and space. Finally, the Perseverance rover was able to acquire the first signature of a visible aurora, corresponding to the atomic oxygen green line emission at 557.7 nm. The next step is now to get highly sensitive images and movies of the visible aurorae, which is the goal of M-AC, the Mars Aurora and dust Camera on board M-MATISSE. Such observations will enable to assess the role of the magnetic field in driving the formation of aurorae, and to identify the profile of energy deposition of the particles.

M-MATISSE (Mars–Magnetosphere ATmosphere Ionosphere and Space-weather ScienceE) is an ESA Medium-class mission (M7) candidate, in competition with two other missions. The selection will be made in June 2026. The goal of M-MATISSE is to understand how the Martian Magnetosphere, Ionosphere, and Thermosphere (M-I-T) system responds to space weather variations with coordinated in situ and remote sensing instruments onboard twin spacecraft.

M-MATISSE will carry the Mars Aurora and dust Camera (M-AC). One of the two spacecraft will host a near ultraviolet (NUV) camera, while the other will be equipped with the first visible camera to observe the Martian aurorae. The NUV camera will measure the CO₂⁺ Fox-Duffendack-Barker (FDB) emission at 367.0–393.2 nm and the visible camera will target the atomic oxygen green line at 557.7 nm. By combining the NUV and visible channels, M-AC will be able to measure the auroral emissions for both the electron (NUV and visible cameras) and proton (NUV) aurorae and to distinguish between the disk reflectance of water ice clouds (NUV) and that of dayside dust (visible). The wide 100° field of view of M-AC will enable coverage of areas larger than 200 km, even at periapsis, with a spatial resolution better than 10 km, and a high temporal resolution down to 1–2 seconds.

M-AC will therefore be an essential instrument to measure the signature of the precipitations of energetic particles into the Mars atmosphere, to assess the role of the magnetic field in driving these precipitations, and to identify the profile of energy deposition. M-AC will also measure the disk reflectance in the dayside to characterize the spatial distribution and evolution of atmospheric dust,

an important driver of the state of the Mars thermosphere.