"Community" Triggers for Rare Solar System Events

Proposed Long-Term Target of Opportunity Trigger with JWST

L.N. Fletcher (University of Leicester, leigh.fletcher@le.ac.uk) and M.H. Wong (UC Berkeley)
on behalf of Solar System GTO and Jupiter ERS Teams

Summary: Solar System events often surprise us, such as giant impacts and eruptions of planetary-scale storms being nearly impossible to predict in advance. JWST would enable detailed characterisation of these extreme and rare events, if one can be captured when the planet is in JWST's field of regard. ***This white paper suggests long-term target-of-opportunity "community" triggers, implemented as a persistent DD programme with limited proprietary time, so that JWST will always be ready to explore these chance-of-a-lifetime phenomena.***

Background: Giant asteroidal or cometary impacts, or enormous storm eruptions, have the potential to change the face of the giant planets on timescales from months to centuries [1-3]. Impact events, such as the 1994 Shoemaker-Levy 9 comet or the Wesley impactor of 2009, provide insights into both the distribution of objects in the outer solar system and the atmospheric response to airburst events (explosions of superheated entry columns, upwelling of deep atmospheric gases, ballistic trajectories of ejecta, shock-induced chemistry, and long-term redistribution of injected material) [4,5]. Storm eruptions can disrupt the energy balance on a planetary scale [6], generating unusual clouds and chemistry, and triggering multi-year (and potentially multi-decade [3]) changes across belts and zones, as witnessed during Saturn's Great White Storm in 2010.

These extreme and rapid changes are in stark contrast to the typical slow variability observed in planetary meteorology and seasonal change. However, they have proven almost impossible to predict in advance, requiring hasty director's discretionary (DD) proposals or target-of-opportunity proposals and triggers that can potentially last for many years. NIRSPEC and MIRI characterisation of an impact or storm could be achieved in ~5 hours. Supporting NIRCAM imaging could be added to precisely map disturbances and to generate iconic solar system images for public engagement. The first-light of the Vera Rubin observatory ushers in an era in which impactors on Jupiter and Saturn—or perhaps even Uranus and Neptune—might actually be predicted ahead of time, enabling characterisation of an impact in the earliest, and most violent stages.

Current Problem: With TACs being largely refreshed from year to year, a successful target-of-opportunity proposal from one cycle can be discarded in the next cycle, even if the successful proposal was never actually triggered. Thankfully, triggers can now span multiple cycles (<3), but even then, the probability of an impact or storm event occurring when the target is in the field-of-regard window (e.g., 50 days for Jupiter) is low, and triggers run the risk of expiring despite their high science value and their approval by a TAC. DD proposals in response to a new event would be slower, risking the loss of an ecliptic visibility window, and it makes sense to be ready with an observation plan.

Proposed Change: Longer-term "community" ToO triggers, implemented as a persistent DD programme and reviewed regularly with community input, would ensure that JWST will always be ready for the "comet of the century", or that wandering interstellar object, or the next "Shoemaker Levy 9" for a giant planet. Alternatively, a mechanism could be created for optional renewals of unactivated TAC-approved ToO triggers after 1-3 years, potentially with limited proprietary time, provided the science remains timely and compelling (and it hasn't been superseded by other GO proposals). This may cut down on workload for the panel and the community, and show the agility and flexibility of JWST for events that will no doubt capture the imagination of the public and professionals alike.

References:

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