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Bolide Impacts in Jupiter's Atmosphere in 2020-2021

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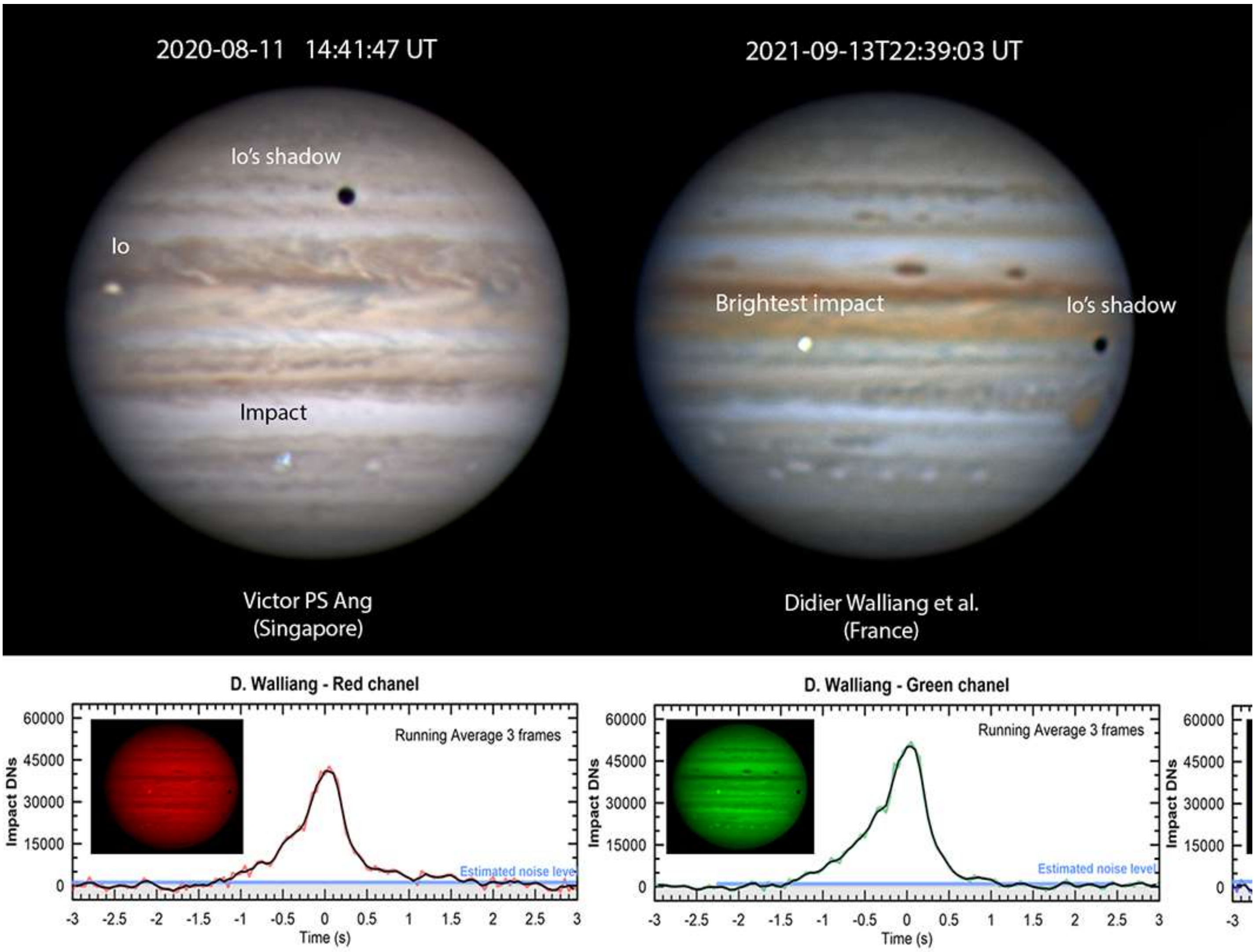
Since 2010 several amateur astronomers have discovered flashes of light that result from the collision of objects of 5-20 m in diameter, impacting in Jupiter's atmosphere at velocities higher than 60 km/s. These objects release energies of the order of 10^{15}-10^{16} J, or 200-1000 kiloton [1] and become observable even with small-size telescopes. Up to 2019, 6 such impact flashes have been observed by amateur astronomers [2-3]. In one case, the quality of the light-curve allowed to investigate the physical composition of the impacting object through the effect of its density when comparing with models of impacts and with the likely conclusion of a stony composition [4]. An important step forward has been the availability of software tools that allow to check video files of Jupiter to automatically search for the faint trace of an impact. The software DeTeCt is a free-software designed for the task [5] and available at: http://www.astrosurf.com/planetessaf/doc/project_detect.php

Here we report the characteristics of 3 additional impacts detected in 2020-2021. These were a very bright flash discovered on 13 September, which was simultaneously observed by at least 9 observers from Brazil to Germany. A new impact was discovered by Kothji Arimatsu from Kyoto University on 15 October 2021, running a dedicated telescope with two CMOS cameras, and also observed by amateur astronomers in Japan and Singapore. After finding this impact, one of these observers used the DeTeCt software on past observations acquired one year earlier on 11 Aug. 2020 finding an additional impact that had passed unnoticed. These 3 impacts in 2020 and 2021 were observed by a variety of cameras with different sensitivities to color. This allows a good quantification of the effective brightness temperature of the impact and a more accurate measurement of the energy released, and thus, a better estimation of the mass of the impactor. The event observed on 13 September 2021 was the brightest flash observed in Jupiter. The 15 October 2021 event was also brighter than most previous flashes and it impacted Jupiter in an area observed by the Junocam instrument 28 hours later. However, Junocam did not observe a remnant even at a spatial resolution over the impact area of ~30 km/pix. We present light-curves of these three impacts and their brightness temperatures from multi-wavelength observations. Brightness temperatures compare well with the spectra of a smaller impact observed in 2018 by the Juno mission [8]. From the light-curves and brightness temperatures we deduce masses, sizes and how these 3 new objects, and the combined data of the DeTeCt project set ups new constrains in the current impact rate in the Jupiter System [3, 7]. We also evaluate the quality of the structures observed in the simultaneous lightcurves and their capability to constrain models of bolides impacting Jupiter's atmosphere [2,4].

Figure: Composite images of the three impacts discussed in this work together with multi-wavelength lightcurves of the central impact from one of the colour videos obtained. The rate between blue and red is indicative of a high brightness temperature.



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Discussion

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