DeTeCt3.1: A software tool to detect impacts of small objects in video observations of Jupiter obtained by amateur astronomers

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Abstract: Impacts of small size objects (7-20 m in diameter) with Jupiter atmosphere result in luminous superbolides that can be observed from the Earth with small size telescopes (32-40 cm). Impacts of this kind have been observed five times by amateur astronomers since July 2010. Although the probability of observing one of these events by an individual observer is very small, the accumulated probability of finding impacts by the large community of amateur astronomers is much higher. Amateur astronomers observe Jupiter using fast video cameras that record thousands of frames during a few minutes which combine into a single image that generally results in a high-resolution image. Flashes are brief, faint and often lost by image reconstruction software. We present major upgrades in a software tool DeTeCt and our current project to maximize the chances of detecting more of these impacts in Jupiter.

Fireballs in Jupiter atmosphere

On June 3, 2010 amateur astronomers Anthony Wesley from Murrumbateman, Australia and Christopher Go from Cebu, Philippines recorded a short flash of light on Jupiter while taking video observations of Jupiter. The observed flash lasted about two seconds and a scientific analysis of its light resulted in the conclusion that it was caused by an object of 8-13 meters impacting on Jupiter’s atmosphere and producing a giant fireball in a superbolide event [1].

Other events have been found later with similar characteristics (see lower box and refs 2&3). In all cases an observed raised the alarm to the amateur community after visually observing the impact flash on the video recording with later confirmations coming from observers who had been taking data at the right time but didn’t see the flash when it produced. In all cases the regions suffering the impacts did not show any trace of the bolide material.

These events can therefore only be discovered if spotted on the few seconds each impact produces a bright fireball observable from ground-based telescopes but some of them are so faint that might be missing by an observer looking at its video data or not observing the video file while being acquired.

Timeline of Jupiter impacts detected

- June 3, 2010 | Observers: Anthony Wesley (Australia) and Christopher Go (Philippines).
- Possible characteristics: 4.7-18 m size object (105-380 Tn in mass; Energy 46-340 kJ)
- August 22, 2010 | Observers: Masayuki Tachikawa, Kazuo Aoki, Masayuki Tanimura (Japan).
- Possible characteristics: 5.8-17 m size object (260-670 Tn in mass; Energy 88-260 kJ)
- Sept. 10, 2012 | Observers: Dan Peterson (University of Arizona and alms) & George Hall (USA).
- Possible characteristics: 7.8-19 m size object (500-910 Tn in mass; Energy 215-405 kJ)
- March 17, 2016 | Observers: Gerrit Kernbauer (Austria) and John McKeon (Ireland).
- May 16, 2017 | Observers: Sauver Pedrighini (France), Thomas Rüssel (Germany) & André Fleckstein (Germany).

Test DeTeCt 3.1

As part of the “Planetary and Space Weather Services” (http://planetaryspaceweather-europa.eu) Europlanet 2020 RI has funded the development of DeTeCt3.1 and further research on impacts in Giant planets. DeTeCt3.1 is an open-source software developed for Windows operating system and incorporates a graphic user interface and some characteristics to find faint impacts. The software is based in the popular DeTeCt software written by Marc Delcroix. The new version has many innovations including a Graphical User Interface that makes much easier to use the tool. The main window shows a console view with text messages and a progress bar. The user can select to show the videos as they are processed with a variety of options including the visualization of differential photometry images. The software produces log files, allows visualization of the detection steps and finally builds detection images that the user can visually inspect. Batch mode is available for the analysis of large sets of videos. The software can be retrieved from: http://pvol2.ehu.eus/psws/jovian_impacts/

DeTeCt3.1 console view with a differential photometry image and the detection image

Please note that you when you run the software you should send to Marc Delcroix (delcroix.marc@free.fr) the DeTeCt Log files for statistical analysis.

Negative detections are also important to constrain the flux of impacts in Jupiter. If you have a positive detection please also send the detection image.

DeTeCtion images (since DeTeCt2.1)

Besides automatic results both versions of DeTeCt incorporate the capability to build a “detection image”. This image is computed from the maximum brightness minus the average brightness for each pixel in the planet and in many cases offers a very high potential for an instantaneous view of the impact. The detection image can filter out spurious results at the limb of the planet from bad seeing or from flickering images of Jupiter’s satellites.

DeTeCt 3.1

DeTeCt is an open source Linux/WIndows application developed by Marc Delcroix that allows to search for impacts in Jupiter videos. The software has been used regularly by dozens of observers examining data equivalent to about 99 days of observations distributed unevenly over the last few years. The software and statistical analysis of its results can be accessed at: http://www.astronet.com/planets/al0x/project_detect.shtml

Statistics as of September 10, 2018

Probability of finding an impact

Based on the current detections, detectable impacts in Jupiter could be frequent (4-5 per year; reference 3) or very rare (3.2 per year, see statistics of the use of DeTeCt above). However more detections are needed to explore this. Jupiter impacts have been found close to Jupiter opposition when the planet is more observed by amateurs. We expect new impact detections as more explore their video observations of Jupiter and the planet’s opposition moves towards summer in the north hemisphere where the highest density of observers live and as Jupiter’s declination increases favoring observations from the North hemisphere. Additionally, frequent observations by larger telescopes (40 cm) using filters where the planet is dark (blues or methane) could seed light in the impact flux by finding impacts of smaller objects not observable with amateur means. These smaller impacts should be more frequent.

References


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