

## Amateur contributions to Jupiter and Saturn science using the PVOL-IOPW database of Giant Planets observations

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### Abstract

Continuous advancement of non-expensive electronic cameras and software tools have allowed a revolution in planetary imaging with small telescopes that initiated with the use of webcam cameras in the late 90s and has now acquired scientific maturity. In this work we present relevant and recent examples of the amateur contribution to scientific research in the study of the atmospheres of the giant planets using the PVOL-IOPW image database. The Planetary Virtual Observatory and Laboratory (PVOL) database of the International Outer Planets Watch (IOPW) atmospheres node is an online and searchable database of images of the giant planets which is contributed from worldwide amateur astronomers and is available to both professional and amateurs [1]. The database is located in the following address: <http://www.pvol.ehu.es/pvol/>.

### 1. Introduction

The Giant Planets Jupiter and Saturn have dynamic atmospheres with complex weather patterns that vary in time in a largely unpredictable way. Studying the recurrent changes and the overall activity of these atmospheres require a nearly continuous monitoring of both planets. This monitoring cannot be fulfilled by the large telescopes available to the community of professional astronomers for two reasons: 1) professional telescopes suffer from large pressures to obtain observation time; 2) most telescopes do not have the adequate instrumentation to obtain high-spatial resolution observations of the planets. Monitoring of Jupiter and Saturn are now best performed by the large community of non-professional astronomers operating small telescopes with diameters on the 20-50 cm. These observers use a “lucky imaging” technique to achieve images that attain the diffraction limit of the telescope by recording video films of the planet, selecting the best individual short exposure frames, and stack them in a

final high-resolution image with a large signal to noise ratio that brings out the fine details in the planet. The IOPW-PVOL database contains more than 12000 observations of this kind of Jupiter and Saturn which are open for research to amateurs and professionals. Instead of describing the database as we have done in the past [1], we point out here to successes in the study of planetary atmospheres when using images provided by amateurs and we point to future fruitful lines of research.

### 2. Successes in professional and amateur collaborations

In recent years completely unexpected phenomena have been discovered thanks to amateur observations. Relevant time critical phenomena discovered in Jupiter thanks to amateur observations are: impacts in Jupiter [2, 3], large convective storms leading to planetary scale disturbances [4], color changes in Jupiter vortices [5]. In other cases small telescopes have been used to survey phenomena that evolve over long temporal scales and require repeated observations over weeks to months. Examples are: long-term motions of vortices [6], mergers of vortices [7], and studies of particular regions [8, 9].

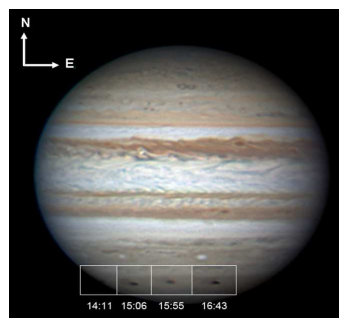


Figure 1: Discovery series of the impact debris obtained on 2009 July 19 by A. Wesley.

For Saturn, relevant examples include the simultaneous discovery by Cassini and amateur observations of the latest Great White Spot in Saturn [10, 11] and long-term studies of mid-scale storms in the Storm-alley [12]

## 2. Contributions of amateur observations to Jupiter and Saturn science.

We list a few scientific research projects that can be run or would benefit from the continuous effort of amateur astronomers contributing observations to public databases such as PVOL.

- 1) Long-term studies of large-scale features such as vortices, barges, plumes and storms including motions and color changes in Jupiter. In Saturn amateur images can be used to study the overall convective activity of the planet in the storm-alley and the behavior of the biggest vortices.
- 2) Long-term monitoring of the zonal winds in Jupiter can be achieved with amateur images.
- 3) Search for unpredicted cometary–asteroidal impact features on both Jupiter and Saturn (see figure 1).
- 4) Characterization of belt-zone reflectivity changes in different years along the Jovian or Saturn seasonal cycle.
- 5) Survey of the eruptions and evolution of large scale convective storms such as Jupiter’s NTBD and SEBDs and Saturn’s Great White Spot GWSs.

## 3. Summary and conclusions

The ensemble of observations contributed by hundredths of keen observers to the IOPW–PVOL database is a very valuable resource for the study of the atmospheres of Jupiter and Saturn. Continuous observations from amateurs have resulted in discoveries of time-critical phenomena on Jupiter and Saturn. Continuous monitoring of Jupiter is now essential to characterize the atmosphere before the Juno arrival to Jupiter (2015) and also before the JUICE-ESA mission (2030). Continuous monitoring of Saturn over the course of the Cassini mission (2004-2017) is also essential.

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