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Digital daylight observations of the planets with small telescopes

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Abstract

Planetary atmospheres are extremely dynamical, showing a variety of phenomena at different spatial and temporal scales, therefore continuous monitoring is required. Amateur astronomers have provided a great amount of observations in the astronomical community. Some of which are unique made under difficult observational conditions. When the planets are close to the sun, observations can only be made either in twilight or in broad daylight. The use of digital technology in recent years has made feasible daytime planetary observing programs. In this work we present the methodology and some results of digital daylight observations (DDO) of planets obtained with a small telescope (11inches, 0.28 m). This work may motivate more observers to digitally observe the planets during the day especially when this can be important and unique.

1. Introduction

Amateur astronomers worldwide continuously capturing many interesting hi-resolution images of the ever changing planetary atmospheres. There are no dedicated earth-based permanent professional programs on planet monitoring, so amateur contribution is considered important [1, 2]. Online databases of planetary images contributed mainly from amateurs are available to both professional and amateurs [3, 4]. Persistency of observations is interrupted when planets apparently approach the sun. Hence there is a need to continue observation during daylight, since planets are very bright and observable. In the past, visual daylight observation has lead to useful scientific results like recording of markings in Mercury by E.Antoniadi [5]. Now days, digital planetary imaging performed in daylight conditions, is extremely challenging but possible. In the following we will provide in brief the planetary imaging methodology with the sun above the horizon and some observational results.

2. Methodology

The basic steps of digital planetary observations are presented at [6]. Though, there are some special difficulties in DDO, which will be presented along with some solutions:

1. *Telescope base alignment.*
2. *Filters*
3. *Position of the planet in the sky*
4. *Finding the planet*
5. *Planetary viewing on the pc screen / Focusing*
6. *Camera settings*
7. *Reflections & Thermal heating*

3. Observations & Results

All DDO's were obtained with a small 0.28m telescope and a DMK21AS618 camera during 2010-2012. Experiments were made in the following wavelength bands: the near infrared band ~700-1000nm (Baader IR685, Asronomik IR742 and Hutech CH4 892 bandpass filters) the visual Red, Green, Blue bands (RGB Astronomik filters) and UV band (UV Venus Astrodon filter). IR filters provide better resolution (suffers less from earth's atmospheric disturbance) but most important are less influenced by broad daylight radiation. In contrast imaging at Blue and UV bands is challenging and in many cases impossible.

3.1 Terrestrial planets

The vicinity of Mercury with the sun, make observations through the day inevitable. Greek astronomer E.M. Antoniadi in 1924-29 used the 83cm- telescope of Meudon Observatory and tried to create the first map of Mercury [5]. He followed the planet to within 4 degrees of the sun's limb proving that visual daylight observations are possible and useful. The hi-res mapping of the planet by the Messenger spacecraft and the absence of atmosphere make Mercury's observations from Earth almost useless. Although, the planet can be a nice target for experiments. DDO revealed some details. As we can see in Fig. 1 patches of dark and bright albedo features, characterizing surface features, can be captured.

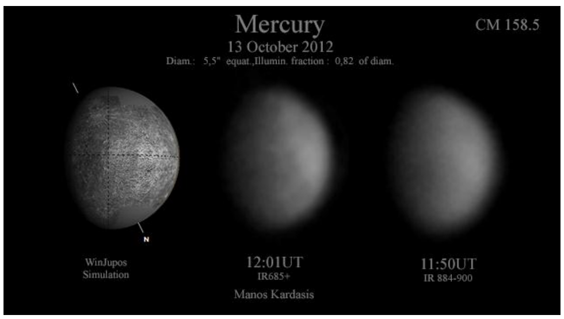

Figure 1. Digital daylight observation (DDO) of planet Mercury (LT +3 hours from UT, Sun's altitude 37.2 deg.)

On the other hand, the dynamic atmosphere of Venus and the apparent vicinity (in many cases) with the Sun requires DDO which can be particularly useful [7]. Some DDO's showing different aspects of Venus are shown at Fig. 2,3,4.

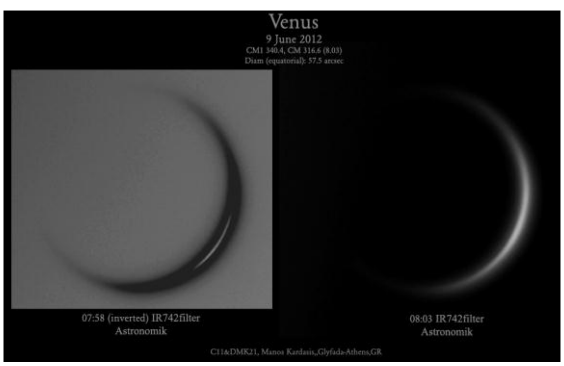

Figure 2. DDO of planet Venus revealing scattering of Sunlight in Venus atmosphere (times in UT, LT is +3hours from UT, Sun's altitude 25.2 deg.)

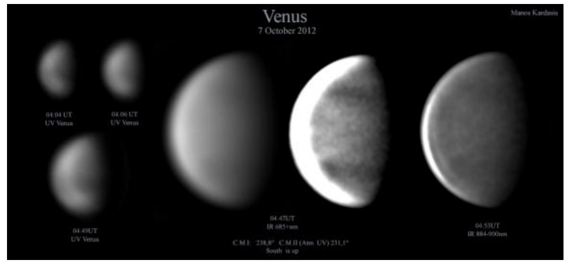

Figure 3. A multispectral DDO set of Venus (times in UT, LT is +3hours from UT, Sun's altitude 3.3 deg.)

Colour observations are very challenging since the blue channel is very difficult to be used as it is biased by sunlit Earth atmosphere. Although it is possible at twilight or, when the sun is low in the horizon (Fig.4).

Figure 4. A colour DDO of planet Venus (time in UT, LT +3hours from UT, Sun's altitude 1.3 deg.)

Mars can also be captured in daylight mainly with IR and R filters. Although, useful cloud- positions capturing with the use of Blue filter is extremely challenging (as mentioned above). Furthermore, when Mars is approaching conjunction the distance from earth is increasing, which results a very small apparent diameter and very low resolution for amateur telescopes.

3.2 Gas giants

The Giant Planets Jupiter and Saturn have dynamic atmospheres with large time-variability. Continuous monitoring is achieved by worldwide observations. In many cases though, fast-evolving weather phenomena needs dense observations. The planet may be visible from the observing site when the Sun is still above the horizon or at twilight. A typical example of this occurred in 2010 on Jupiter's "SEB Revival" [8]. It is the most dramatic meteorological event on Jupiter's atmosphere and its evolution needed to be followed in every rotation of the Planet. The meridian of the “SEB Revival source area” was passing above local skies during daytime. In Fig.5 there is colour image made from R-G-B filter composition showing the evolution of the phenomenon 18 rotations of the planet after it started.

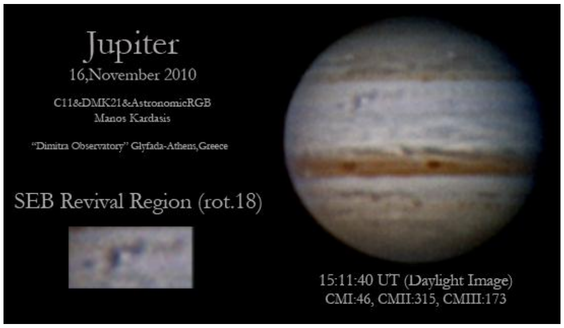

Figure 5. A colour DDO revealing the Jupiter’s 2010 SEB Revival source, (Local time, 2hours from UT, near sunset)

When Saturn or Jupiter are getting away from Earth, and as they approach conjunction the apparent disc diameter is getting small and they become very close to the sun. In these conditions observations can only be achieved with DDO’s, and in some cases they can be very fruitful.

A typical example is the following. A few weeks before conjunction of Jupiter on May, 14th 2012, two important disturbances started in the North Equatorial Belt (NEB) and North Temperate Belt (NTB). Jupiter reappeared in early June 2012 but was very close to the sun for observations, even at twilight. DDO's of Fig.6 confirmed that both outbreaks had developed impressively leading to a North hemisphere upheaval [11].

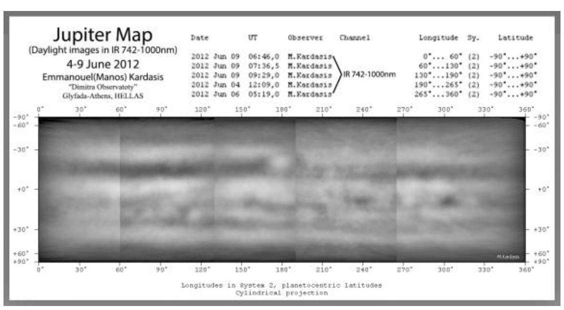

Figure 6. The first Map of Jupiter of the obs.period 2012/13 [9] made with DDO’s and the use of WinJupos software [10]. It confirmed the North hemisphere Upheaval [11]. (Local time, 3 hours from UT, Sun’s altitude 41.2, 51.1, 70.5, 62.4, 24.2 deg.)

4. Summary and Conclusions

Modern capturing methodology and image processing techniques allow planetary observations almost all-year and all-day long. We presented the methodology and some preliminary results in some planets. Adaptations to the classic night-capturing methodology for digital daylight observations (DDO) were discussed. Experiments were performed on Mercury, Venus and especially on Jupiter. This work may motivate DDO by amateurs in a large extent especially in cases were detected changes may be very useful.

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