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A method for conducting dark sky surveys and light pollution monitoring with the contribution of amateur astronomers and students

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Abstract: A method is proposed for light pollution monitoring using easily available and inexpensive equipment in place of sophisticated instruments for photometry and spectrometry. The instrument is a portable photometer called Sky Quality Meter. It is endorsed by the International Darksky Association and has been used in similar surveys around the world. Conducted small scale dark sky surveys by the author in the region of Achaia and mount Hymettus in Attica conclude that this instrument is suitable for dark sky surveys and accurate enough for serious work in light pollution monitoring. Moreover, it is proposed that this instrument can be used to conduct a country-wide dark sky survey with the participation of education institutes as well as amateur astronomers.

1 Introduction

Light pollution is the sky glow produced by artificial lighting that hinders the visibility of stars and other celestial objects. A significant part of light pollution is due to inefficient public lighting, mostly in urban areas. Light pollution needs to be carefully monitored in order to preserve dark sites where important astronomical activity takes place [1],[2]. Monitoring light pollution can help prevent its growing, evaluate measures taken against light pollution and also assess how it is connected with specific human activity. In order to map the light pollution of a specific geographical area, a number of measurements are needed, spread out to the extent of the area. A dark sky survey is the collection of data regarding the sky glow of a certain geographical area due to light pollution or other sources [3]. While a number of ways exist to measure light pollution [4], the most versatile for large scale surveys that can be conducted with the help of amateur, students or volunteers is with the use of portable photometers [5].

2 Description of the method

The main instrument used in the proposed methodology is a Unihedron Sky Quality Meter L [6]. This instrument can measure the brightness of the night sky in magnitudes per square arc second. This device provides an easy, affordable (100) and portable method of measuring sky brightness. Moreover, it is endorsed by the International Dark sky Association and therefore has been used extensively globally allowing for comparison of results from other efforts [3],[5]. The instrument measures the brightness of the night sky in magnitudes per square arc second. The field of view is practically considered to be about 10 degrees. The HWHM of the relative radiance vs. angle is about 10 degrees and relative radiance becomes practically zero at 30 degrees. Its relatively narrow field of view means that measurements are largely unaffected by direct adjacent lighting and the presence of bright objects such as the moon in the other side of the sky. A measurement in a dark site in the region of Achaia, Greece showed that a measurement of about 21 magnitudes correspond to a truly dark site with a visual limiting magnitude of 6.5. Mid-range of the instrument, suburban skies of limiting magnitude 5, correspond to a measurement of about 19.5 and heavily polluted urban areas, limiting magnitude 4.5, correspond to a measurement of about 18. Lower readings such as 16.5 can be had when direct lighting interferes.

3 Practicalities

In order for measurements to be taken and using standard methodology [7] the instrument must be fixed to a tripod containing a bubble level so it can point to zenith when fixed perpendicularly. Moreover, a protractor can be used in order to be able to point the instrument towards 45 or 30 degrees altitude. A compass can also used when not pointing towards the zenith in order to record the direction of the measurement. Data that needs to be recorded during the measurements include the following: Readings from the instrument (magnitudes per square arc second and temperature), Date/time, Location with coordinates (from GPS), Weather and atmospherical seeing conditions, Presence of celestial objects (moon, planets, the milky way etc)

Planning of the measurements includes choice of location and time for the measurement. Locations can be chosen based on various criteria, including monitoring urban extension or monitoring dark sites of interest to astronomers. Regarding choice of time, the true potential of the skys darkness could be achieved on moonless nights, or after the moon has set, after the end of twilight and on clear nights. However, in order to fully record how factors such as weather, transparency and presence of celestial objects affect the sky brightness, a number of measurements with varying influence from these factors needs to be taken.

4 Involvement of amateur astronomers, students and the Greek light pollution campaign

Country-wide light pollution monitoring needs both a great number of measurements, in order to cover most of the country, as well as frequent re-measurements to record how light pollution changes over time. These factors together with the simplicity of the method, make schools, universities and amateur astronomy associations ideal partners for light pollution monitoring programs. On their side, this can be part of learning in a science or environmental class in secondary education, physics or astronomy class in University and light pollution monitoring of sites suitable for astronomical observation by amateurs.

Since April 2009, the web site under the title darksky.gr aims to communicate the problem of light pollution to the public [8]. The site aims to become a meeting point and unite the efforts of Greek amateur astronomy clubs and other organizations interested in the issue. We believe that a hub for country-wide light pollution measurements using the proposed method can be created in this site in order to gather and combine measurements from amateur astronomers, schools and universities.

References

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