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Effects of Extragalactic Background Light on Deep Surface Photometry of Galaxies

Erik Zackrisson,[1,2,3] and Göran Östlin[2]

Abstract. Surface photometry of galaxies at very faint surface brightness levels is largely limited by problems in subtracting the night sky with sufficient accuracy. While most of the sky flux comes from regions inbetween the observer and the target galaxy (i.e. airglow, zodiacal light, light from the Milky Way), a small fraction - the extragalactic background light - comes from behind the object studied. Here, we argue that since this part of the sky flux can be subject to extinction by dust present in the target galaxy, standard reduction procedures will lead to a systematic oversubtraction of this component. This can introduce spurious features in the luminosity and colour profiles of galaxies at surface brightness levels similar to that of the extragalactic background itself.

1. Deep Surface Photometry and Extragalactic Background Light

Surface photometry of galaxies at very faint surface brightness levels is largely limited by problems in subtracting the night sky with sufficient accuracy. As an example, surface photometry at $\mu_V \approx 27.0$ mag arcsec^{-2} with an error of ± 1.0 mag or less requires that the sky background can be subtracted with an accuracy better than 99% – a daunting task by itself. Here, we argue that a hitherto unrecognized effect related to the extragalactic background light (EBL) should it even more so, possibly calling a host of previously published results on the faint outskirts of galaxies into question.

While most of the sky flux comes from regions inbetween the observer and the target galaxy (i.e. airglow, zodiacal light, light from the Milky Way), a small fraction - the EBL - comes from behind the object studied. Since this part of the sky flux can be subject to extinction by dust present in the target galaxy, the standard procedure of estimating the sky flux at locations in the image frame well away from the target object will result in a slight overestimate of the sky flux relevant *inside* the contours of the galaxy. Hence, sky subtraction based on such estimates will lead to a systematic oversubtraction of this component. This has a completely negligible impact on the integrated total luminosities and colours of bright galaxies, but can introduce spurious features in the luminosity profiles of galaxies at very faint surface brightness levels.

This effect will start to become important as soon as the surface brightness level of the target galaxy approaches that of the EBL in the filter used. Based

[1]Tuorla Observatory, University of Turku, Väisäläntie 20, FI-21500 Piikkiö, Finland

[2]Stockholm Observatory, AlbaNova University Center, 106 91 Stockholm, Sweden

[3]Department of Astronomy and Space Physics, Box 515, 751 20 Uppsala, Sweden

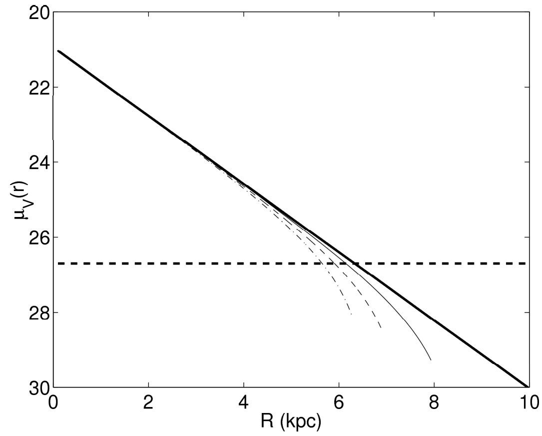

Figure 1. Because of EBL oversubtraction, the V-band surface brightness profile of a bright exponential disk (thick solid line) will after reductions resemble one of the curved profiles, depending on the extinction. The different curved profiles correspond to extinction values towards the stars in the disk of $A_{\rm V} = 0.1$ (thin solid), 0.3 (thin dashed) and 0.8 mag (thin dash-dotted). The extinction is assumed to be constant across the disk, and to be 50% of that experienced by the EBL. This corresponds to a dust geometry of a "flat dust shell" (i.e. a double dust screen). The horizontal, thick dashed line indicates the surface brightness of the EBL in this filter.

on interpolations between current EBL measurements (Wright 2001; Bernstein, Freedman & Madore 2005; Matsumoto et al. 2005) we estimate the surface brightness of the EBL to be: $\mu_B \approx 27.2$, $\mu_V \approx 26.7$, $\mu_I \approx 25.5$ and $\mu_K \approx 23.0$ mag arcsec^{-2}. The size of the EBL effect is very sensitive to the distribution of dust inside the target galaxy. Fig. 1 illustrates the effect on the V-band surface brightness profile of a bright exponential disk (thick solid). Because of EBL oversubtraction, the profile measured will resemble one of the curved profiles, depending on the extinction. Hence, the EBL effect can mimic a soft disk truncation. Since the size of this effect depends on the ratio of the flux from the galaxy to the flux of the EBL, it will vary depending on the filter used. Because of this, spurious colour gradients can also be produced, either in the redward or blueward direction. A more detailed description of EBL effect and its implications will appear the in a forthcoming paper (Zackrisson & Östlin, in preparation).

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References

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