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Measurement of the cosmic optical background using the long range reconnaissance imager on New Horizons

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The cosmic optical background is an important observable that constrains energy production in stars and more exotic physical processes in the universe, and provides a crucial cosmological benchmark against which to judge theories of structure formation. Measurement of the absolute brightness of this background is complicated by local foregrounds like the Earth's atmosphere and sunlight reflected from local interplanetary dust, and large discrepancies in the inferred brightness of the optical background have resulted. Observations from probes far from the Earth are not affected by these bright foregrounds. Here we analyse the data from the Long Range Reconnaissance Imager (LORRI) instrument on NASA's New Horizons mission acquired during cruise phase outside the orbit of Jupiter, and find a statistical upper limit on the optical background's brightness similar to the integrated light from galaxies. We conclude that a carefully performed survey with LORRI could yield uncertainties comparable to those from galaxy counting measurements.

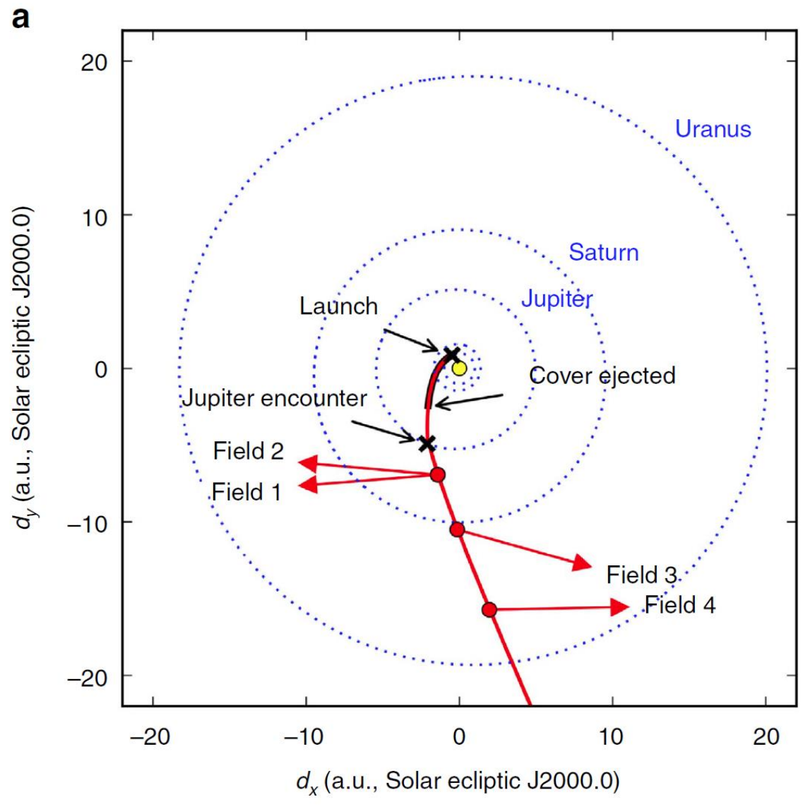

Figure 1 | The trajectory of New Horizons through the solar system. Data collection periods of relevance to this study are indicated. Both the $x-y$ and $r-z$ planes are shown (**a**,**b**, respectively), with the axes in solar ecliptic units and $d_r=\sqrt{d_x^2+d_y^2}$. New Horizons was launched from Earth at 1 a.u., and the data with the LORRI dust cover in place were acquired at 1.9 a.u., just beyond Mars' orbit at 1.5 a.u. (inner blue dotted lines). The dust cover was ejected near 3.6 a.u., and the data were acquired before and during an encounter with Jupiter. The data considered here were taken between 2007 and 2010 while New Horizons was in cruise phase. The red vectors indicate the relative positions of fields $1-4$ compared to the sun and plane of the ecliptic.

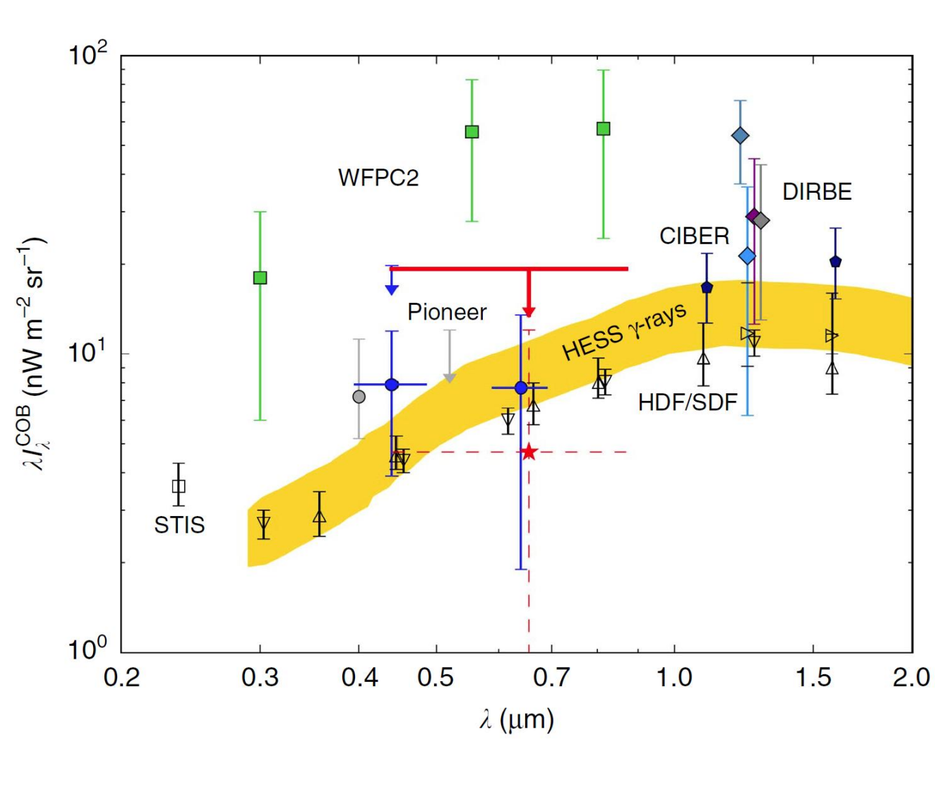

Figure 2 | Measurements of the COB surface brightness. The λI_λ^{COB} determined in this study are shown as both an upper limit (red) and a mean (red star). We also show previous results in the literature, including direct contraints on the COB (filled symbols) and the IGL (open symbols). The plotted LORRI errors are purely statistical and are calculated from the observed variance in the mean of individual 10 s exposures; see Fig. 3 for an assessment of the systematic uncertainties in the measurement.

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