

put for IRIS2 (Ellis et al. 2012). Figure 1a shows the OH suppressed spectrum from sky frame 1 in Table 1 with the best-fitting black-body model shown by the dashed curve and the continuum points used to compute the best-fitting model shown by squares.

Next, the sky spectra were divided by the instrument response, which corrects for variation in throughput with wavelength and telluric features. The instrument response was measured from a sky-subtracted A0V standard star observation. The stellar spectrum in each fibre was divided by a model spectrum of Vega (Castelli & Kurucz 1994) and normalised to the mean value between $1.5 - 1.69 \mu\text{m}$.

Lastly, the sky spectra were flux-calibrated assuming an efficiency of 4 per cent based on throughput measurements of GNOSIS, IRIS2, and estimates of the AAT (Ellis et al. 2012; Trinh et al. 2012). Figure 1b shows the dark-subtracted, thermal-subtracted, flux-calibrated OH suppressed spectrum from sky frame 1.

4 INTERLINE BACKGROUND SOURCES

Below we discuss the main NIR interline background sources, which include non-thermal atmospheric emission (OH and other molecules), zodiacal scattered light and scattered moonlight. Other contributions, such as zodiacal emission from interplanetary dust at the ecliptic plane, Galactic dust emission from interstellar dust and the cosmic microwave background are negligible in the H band (Ellis & Bland-Hawthorn 2008). Thermal emission was removed as fully as possible during our data reduction.

4.1 Atmospheric emission

The interline background is likely to contain a strong atmospheric component that may be composed of OH light scattered by the diffraction grating of the spectrograph, either from suppressed or unsuppressed OH lines and/or emission from other atmospheric molecules. The temporal behaviour of such molecular emission arises from physical processes that affect that reactions rates between atmospheric molecules. The emission intensity varies spatially due to the airmass. As such, the temporal and spatial parts are independent and the emission from an atmospheric molecule may be written as

$$I(t, z) = I_0(t)X(z), \quad (2)$$

where t is the time after sunset, $I_0(t)$ is the time-dependent intensity specific for each atmospheric molecule, z is the zenith distance and $X(z)$ is the optical path or airmass.

For OH emission emitted from a layer at height $h \approx 87 \text{ km}$ (Baker & Stair 1988), the optical path is given by the van Rhijn factor (van Rhijn 1921)

$$X_1(z) = \left[1 - \left(\frac{R}{R+h} \right)^2 \sin^2 z \right]^{-1/2}, \quad (3)$$

where R is the radius of the Earth. For more general atmospheric emission where the emitting height is unknown, the optical path is given by the standard expression

$$X_2(z) = \sec(z). \quad (4)$$

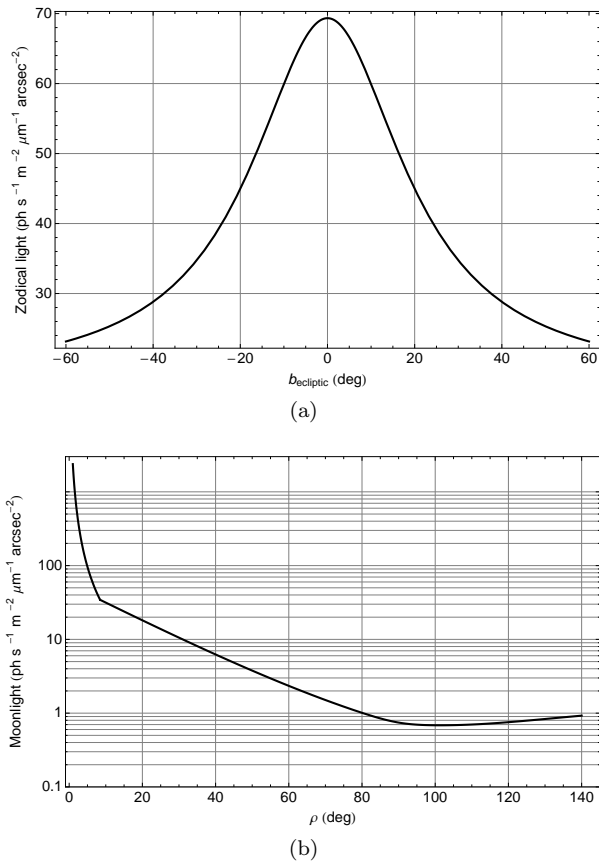


Figure 2. (a) The zodiacal scattered light model from Ellis & Bland-Hawthorn (2008) based on J band measurements from Kelsall et al. (1998) with a $T = 5800 \text{ K}$ and $\epsilon = 1.08 \times 10^{-13}$ black-body spectrum. (b) The scattered moonlight model extrapolated from the V band measurements of Krisciunas & Schaefer (1991) using the wavelength dependence of Rayleigh and Mie scattering for $\lambda = 1.520 \mu\text{m}$, $\alpha = -80 \text{ deg}$, $z_{\text{sky}} = 0 \text{ deg}$, and $z_{\text{moon}} = \rho$.

Excited OH radicals are primarily created by a reaction between hydrogen and ozone (Bates & Nicolet 1950)



and may be quenched by reactions such as (Llewellyn et al. 1978)



The temporal behaviour of OH emission varies on both short and long time-scales due to physical processes that affect these chemical reactions. On short time-scales, OH intensity fluctuates by ≈ 15 per cent over periods of 15 minutes (Taylor et al. 1991) to 1 hr (Yee et al. 1991) due to gravity waves (Ramsay et al. 1992; Frey et al. 2000) that induce density and temperature perturbations.

On long time-scales, OH intensity decreases throughout the night by a factor of 2-3 (Ramsay et al. 1992; Content 1996; Glazebrook & Bland-Hawthorn 2001) due to changes in the altitude-number density profiles of the minor atmospheric constituents as a result of the lack of sunlight (Shimazaki & Laird 1970). The long-term decline of OH emission through the night is typically modelled as linear (Content 1996; Sullivan & Simcoe 2012).