

K band imaging with MCAO

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Aim: to test whether cooling MCAO will make a significant impact on the sensitivity of *K* band imaging.

The full *K* band is between about $1.95\,\mu\text{m}$ and $2.5\,\mu\text{m}$. The sky transmission is consistently too low below and above these wavelengths. Figure 1 shows a model sky transparency for MK¹ with a water vapour column of 1.6 mm and observing at an airmass of 1.5.

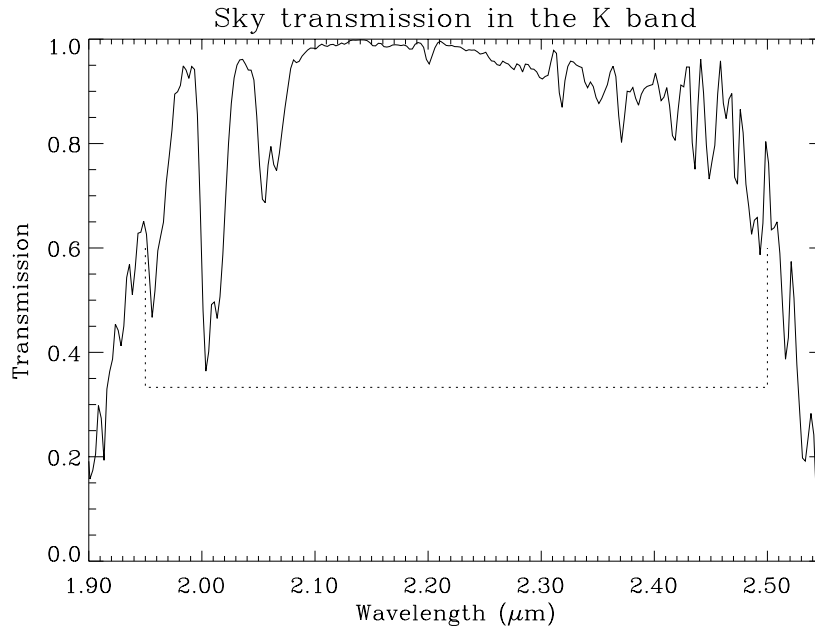


Figure 1: Model sky transparency for MK with a water vapour column of 1.6 mm and observing at an airmass of 1.5. The dotted line shows the range of the *K* band considered in this report. The transmissions are plotted with a resolution of about 5 nm.

¹http://www.gemini.edu/sciops/ObsProcess/obsConstraints/atm-models/trans_16_15.dat

Two models were chosen for the sky and telescope background:

1. a selection of OH lines based on various sources, e.g., Oliva & Origlia (1992)²; 2% emissivity from Gemini at 5°C ; 18% emissivity from the sky at -10°C .
2. model sky background at MK³; 2% emissivity from Gemini at 5°C .

The solid lines in Figures 2 and 3, respectively, show these sky spectra. The first gives an optimistic background of $K_{2.2} \approx 14.6 \text{ mag arcsec}^{-2}$ and the second gives a background of $K_{2.2} \approx 13.3 \text{ mag arcsec}^{-2}$ ($K_{2.2}$ is the Vega magnitude with a $2.0\text{--}2.4 \mu\text{m}$ filter).

MCAO was assumed to have an emissivity of 18%. The dashed lines in Figures 2 and 3 show the background from MCAO at 5°C , -5°C and -15°C . The dotted lines show the sky and telescope backgrounds combined with MCAO at 5°C background.

The limiting sensitivities using MCAO at various temperatures in comparison with no AO are given in Tables 1 and 2 [for conversion: $K_{2.2} \approx 14.52$ (1000 μJy); $K_{2.2} \approx 22.02$ (1000 nJy); $K_{2.2} \approx 23.77$ (200 nJy)].

- With a low sky and telescope background, gain 1.5–1.8 mag using MCAO compared to no AO and gain a further 0.3–0.4 mag by cooling MCAO to -15°C (Table 1).
- With a high sky and telescope background, gain 1.7–2.0 mag using MCAO compared to no AO and gain a further 0.1–0.2 mag by cooling MCAO to -15°C (Table 2).

²A&A, 254, 466

³http://www.gemini.edu/sciops/ObsProcess/obsConstraints/atm-models/nearIR_skybg_16_15.dat

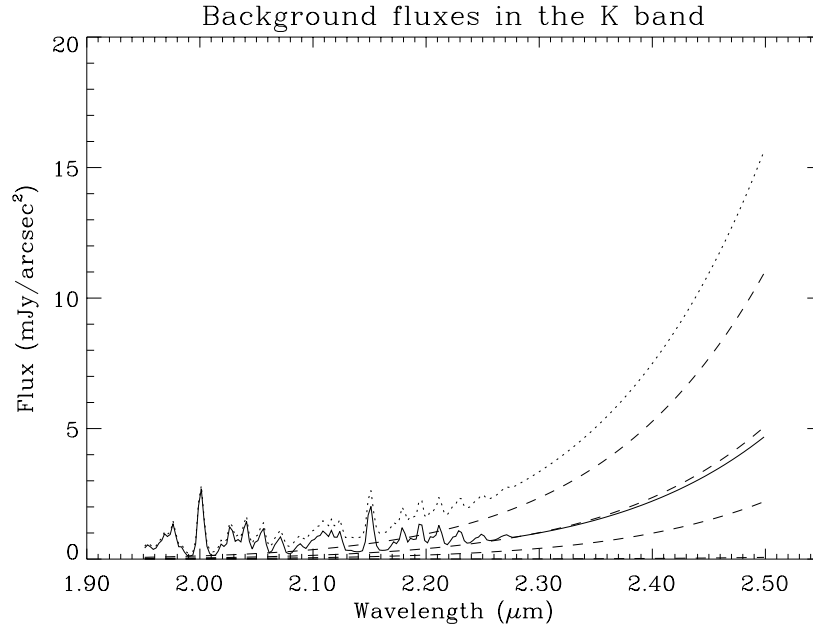


Figure 2: The sky and telescope background using Model 1 is represented by the solid line (see page 2 for description of the models). The dashed lines represent the thermal backgrounds for MCAO at 5°C , -5°C and -15°C , while the dotted line is the combined background of sky, telescope and MCAO at 5°C . The fluxes are plotted with a resolution of 5 nm.

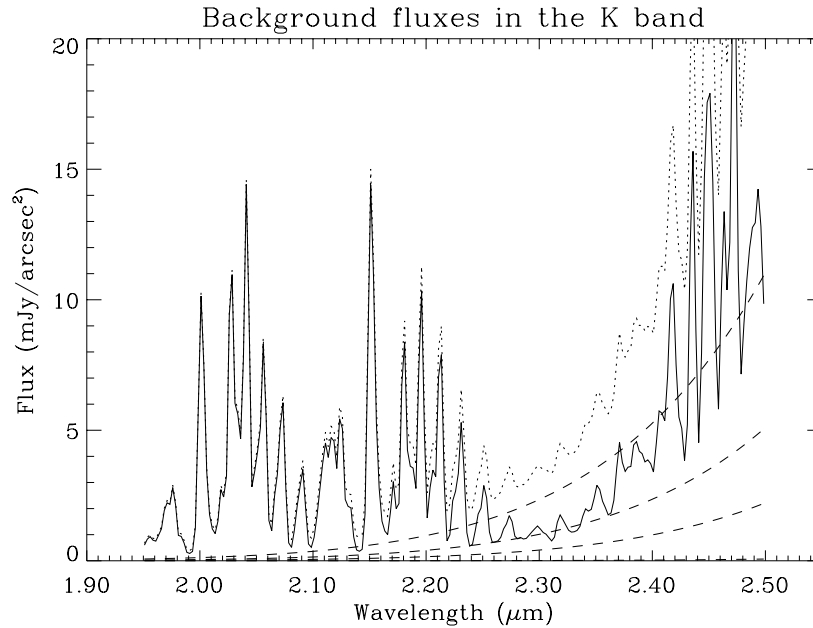


Figure 3: The sky and telescope background using Model 2 is represented by the solid line. See Figure 2 for further details.

Table 1: Imaging with background $K_{2.2} \approx 14.6$ mag arcsec $^{-2}$ (sky and telescope)

	No AO	MCAO			
temperature of MCAO ($^{\circ}\text{C}$)	—	5	-5	-15	-50
background ^a 2.0–2.4 μm ($\mu\text{Jy arcsec}^{-2}$)	940	2387	1564	1192	946
throughput ^b	0.44	0.33			
aperture (arcsec)	0.60×0.60	0.06×0.06			
enclosed energy	0.55	0.45			
lim. sensitivity ^c 1.95–2.3 μm (nJy)	753	146	125	114	107
lim. sensitivity ^c 2.0–2.4 μm (nJy)	803	179	146	128	114
lim. sensitivity ^c 2.1–2.5 μm (nJy)	1079	264	210	179	154

^asee Figure 2 for sky spectrum;

^binstrument throughput only, sky transmission is shown in Figure 1 [giving sky transmissions of 0.895 (1.95–2.3 μm), 0.916 (2.0–2.4 μm), 0.922 (2.1–2.5 μm) for the broadband filters];

^climiting point-source flux (S/N of 10, total integration of 1 hour).

Table 2: Imaging with background $K_{2.2} \approx 13.3$ mag arcsec $^{-2}$ (sky and telescope)

	No AO	MCAO			
temperature of MCAO ($^{\circ}\text{C}$)	—	5	-5	-15	-50
background ^a 2.0–2.4 μm ($\mu\text{Jy arcsec}^{-2}$)	3182	4627	3805	3434	3188
throughput ^b	0.44	0.33			
aperture (arcsec)	0.60×0.60	0.06×0.06			
enclosed energy	0.55	0.45			
lim. sensitivity ^c 1.95–2.3 μm (nJy)	1545	240	228	223	219
lim. sensitivity ^c 2.0–2.4 μm (nJy)	1477	250	228	217	209
lim. sensitivity ^c 2.1–2.5 μm (nJy)	1833	337	296	276	260

^asee Figure 3 for sky spectrum;

^{b,c}see Table 1.