“Lines and continuum sky emission in the near infrared: observational constraints from deep high spectral resolution spectra with GIANO-TNG”

Oliva *et al.*, 2015 http://arxiv.org/abs/1506.09004 (to be published in A & A)

Abstract

Aims. Determining the intensity of lines and continuum airglow emission in the H-band is important for the design of faint-object infrared spectrographs. Existing spectra at low/medium resolution cannot disentangle the true sky-continuum from instrumental effects (e.g. diffuse light in the wings of strong lines). We aim to obtain, for the first time, a high resolution infrared spectrum deep enough to set significant constraints on the continuum emission between the lines in the H-band.
Methods. During the second commissioning run of the GIANO high-resolution infrared spectrograph at the La Palma Observatory, we pointed the instrument directly to the sky and obtained a deep spectrum that extends from 0.97 to 2.4 μm.
Results. The spectrum shows about 1500 emission lines, a factor of two more than in previous works. Of these, 80% are identified as OH transitions; half of these are from highly excited molecules (hot-OH component) that are not included in the OH airglow emission models normally used for astronomical applications. The other lines are attributable to O_2 or unidentified. Several of the faint lines are in spectral regions that were previously believed to be free of line emission. The continuum in the H-band is marginally detected at a level of about 300 photons/m^2/s/arcsec^2/μm, equivalent to 20.1 AB-mag/arcsec^2. The observed spectrum and the list of observed sky-lines are published in electronic format.
Conclusions. Our measurements indicate that the sky continuum in the H-band could be even darker than previously believed. However, the myriad of airglow emission lines severely limits the spectral ranges where very low background can be effectively achieved with low/medium resolution spectrographs. We identify a few spectral bands that could still remain quite dark at the resolving power foreseen for VLT-MOONS (R≈6,600).

【背景】
(1) Y, J, Hバンド(0.9~1.8um)は OHや O_2分子からの輝線に占められている。
(2) これら輝線はかなりnarrow なので高分散分光観測で特定してマスクしてやれば、
大気由来の背景ノイズを桁で下げられる (“OH sky-suppression”)。
(3) 一方、airglow line間のsky continuumの定量的評価は実はきちんとされてこなかった。
e.g. Maihara *et al.*, 1993 の報告 “19.4 AB-mag/arcsec^2@1.665um” から目立った進展なし。
↓
本論文の意義はHバンドでsky continuum emission を(これまでで一番)精度よく決めたこと。

【近年の研究研究】
・ Y, Jバンド (< 1.3 um) : R~6,000の観測データあり (Sullivan & Simcoe 2012)
・ Hバンド (1.5-1.8um) : 本研究。R~50,000の観測。

【観測】
・GIANO/TNG3.6m telescope (echelle spectrograph)
・0.97-2.4 um w/ R~50,000
・積分時間は2 hours。Darkとflatフレームも取得。
・波長較正はU-Neランプを使用 (決定精度~0.07 Å r.m.s.)
・(本筋とは関係ないが) Hawaii-II PACE ← remarkably low read-out noise (Oliva 2012b)

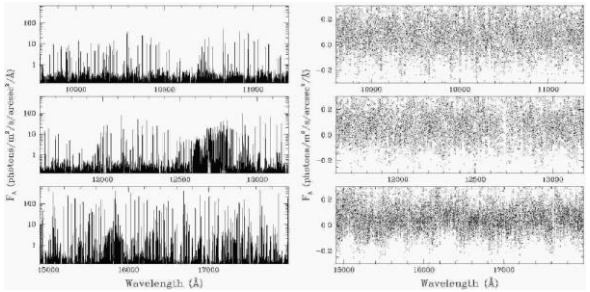
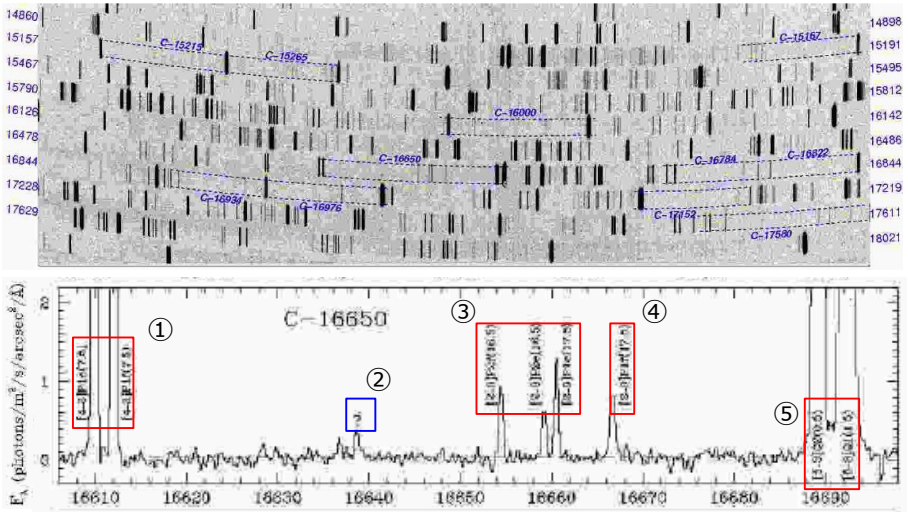


Fig.4

Fig.3



例：C-16650 (Maihara 1993 と同じ波長帯域)
この波長帯はline free と考えられていた。
上記文献では sky continuum emissionのフラックス = 590 photons/m2/sec/arcsec2/um (⇔ ~19.4 AB-mag/arcsec)
← このフラックスの内65%が5つのlineからの寄与であることが今回の研究で判明。
真のcontinuumは200 photons/m^2/sec/arcsec^2/um (⇔ ~20.6 AB-mag/arcsec^2)

【結論】
・ 0.97-2.4 umで約1500の airglow lines を検出。
・Hバンドでsky continuum emission のフラックスは 300 photons/m^2/sec/arcsec^2/um (⇔ ~20.1 AB-mag/arcsec^2)
・今回の分光データは公開されている。

＃低／中分散の近赤外分光装置でfaint な天体を深く分光する際には、sky continuumの正確な情報は貴重だろう。(i.e. continuumが 暗い波長域を狙うのが得策)