Atmospheric Studies with GTC: Qatar-1b

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The GTC exoplanet transit spectroscopy survey:

- A project to take advantage of the 10m GTC capabilities.
- OSIRIS instrument in the spectroscopic mode.
  (2 CCDs, 2048x4102 pix2, FoV ~ 8 arcmin)
- ~10 planets already observed (1-2 transits).
- WASP43b (Murgas et al. 2014)

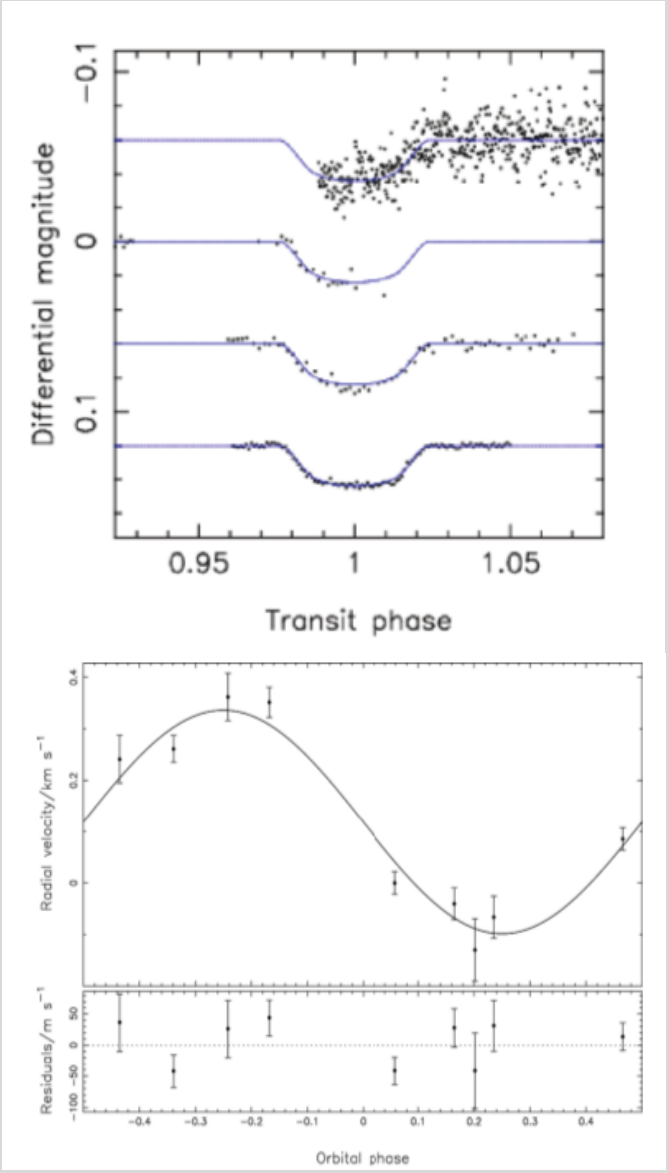
Team:
E. Palle, R. Alonso, G. Nowak, F. Murgas, H. Parviainen, L. Nortmann, N. Iro, G. Chen

Qatar-1b (Alsubai et al. 2011)

- 1.1 x Jupiter Mass
- 1.16 x Jupiter Size
- Orbital Period of 1.42 days
- Host Star:

  K dwarf, T_eff ~ 4900 K,

  V=12.8 mag



Observation Setup

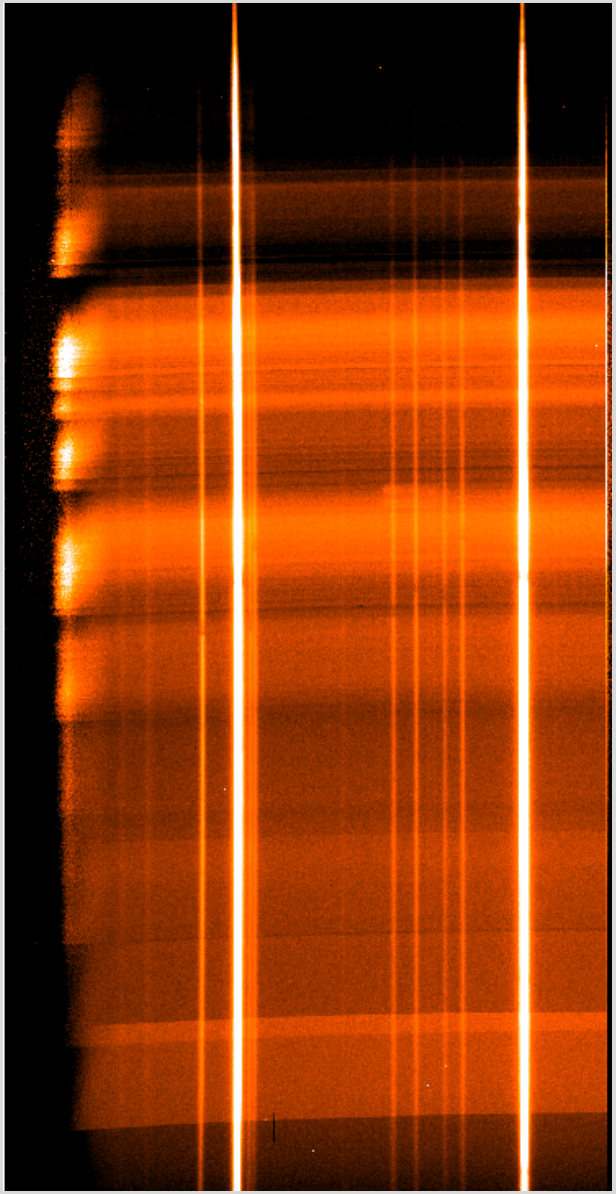
OSIRIS - spect. mode

Long+Wide Slit (40 arcsec)

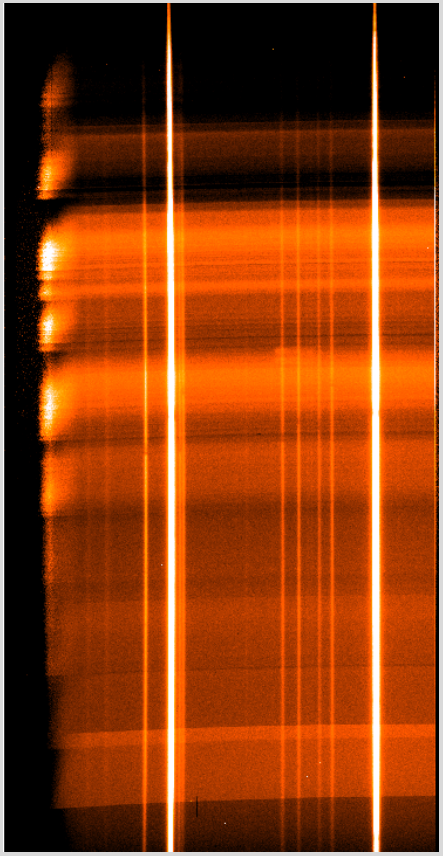
R1000R grism

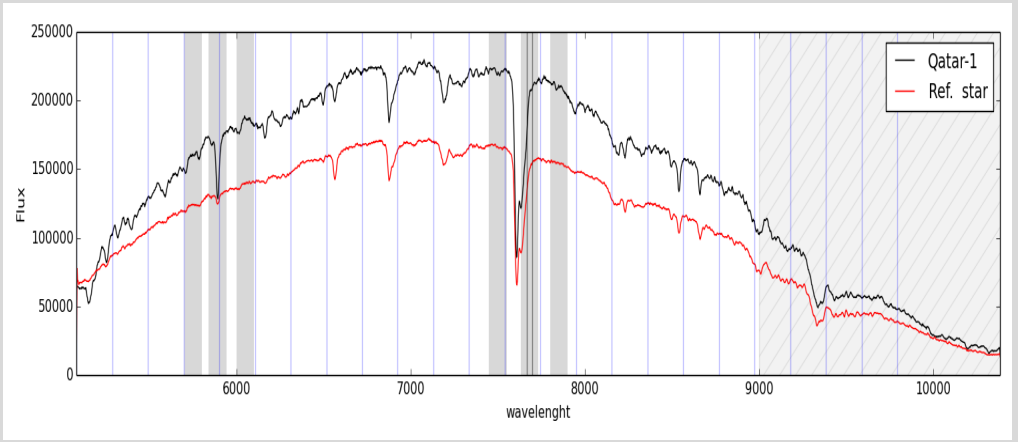
Target + Reference in same chip

(2098 x 4102 pix)

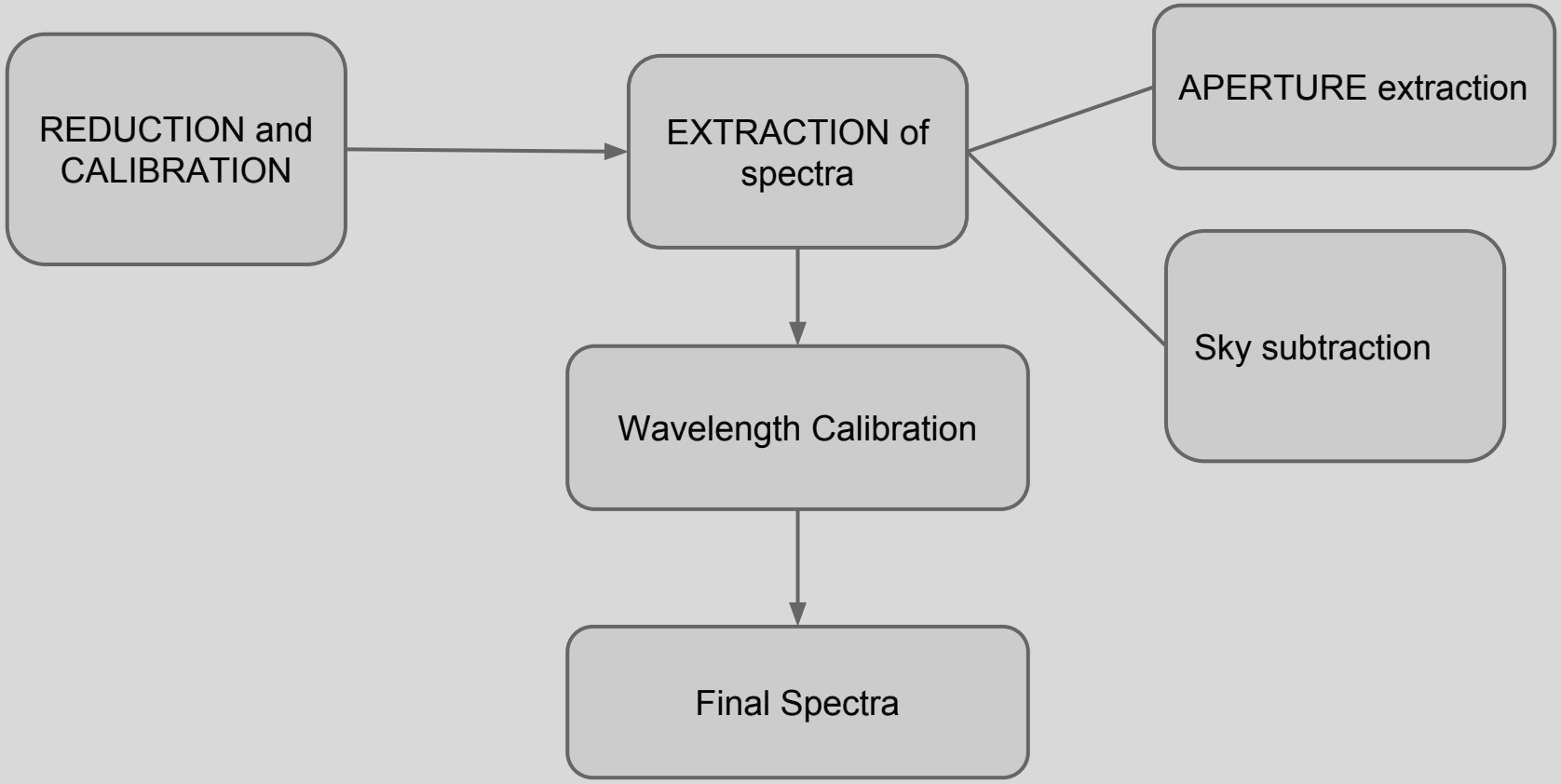


Observation Reduction and Calibration

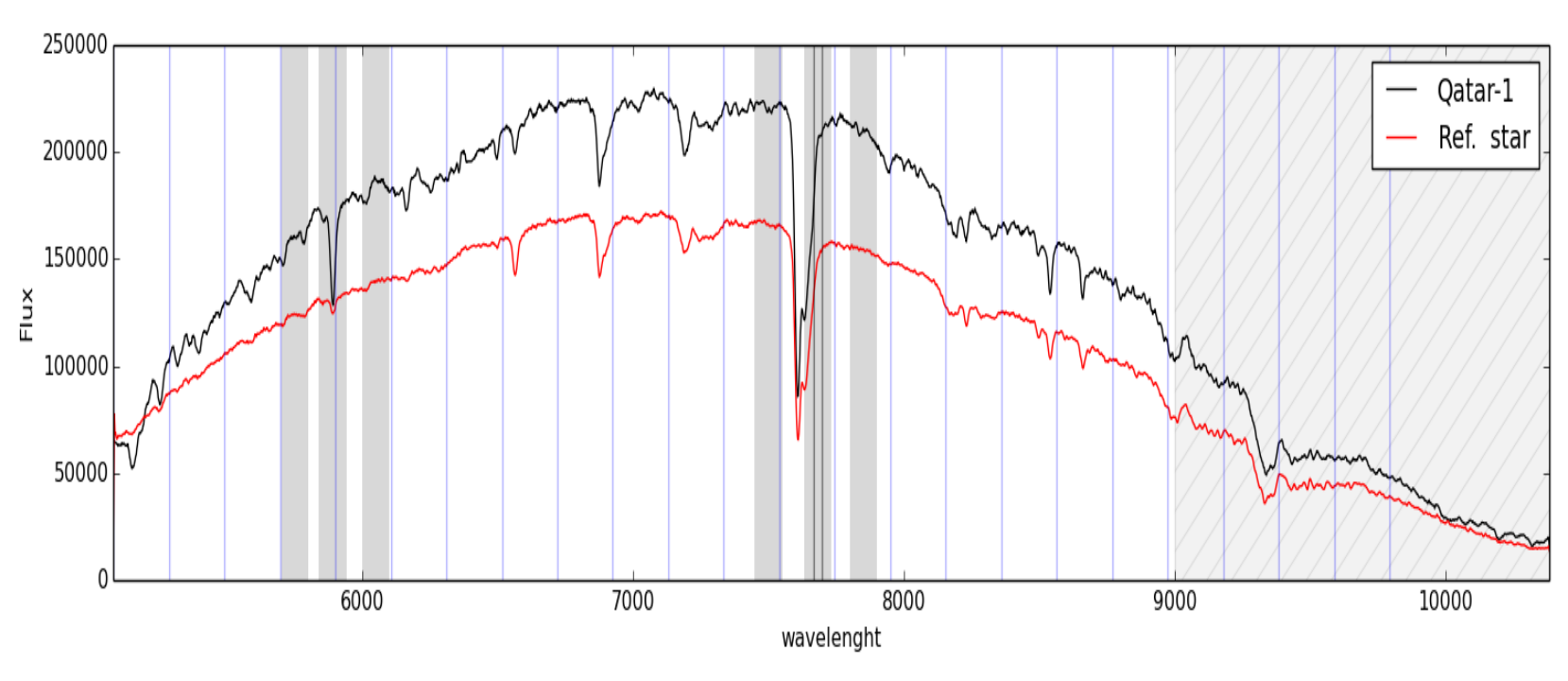




Pipeline Steps

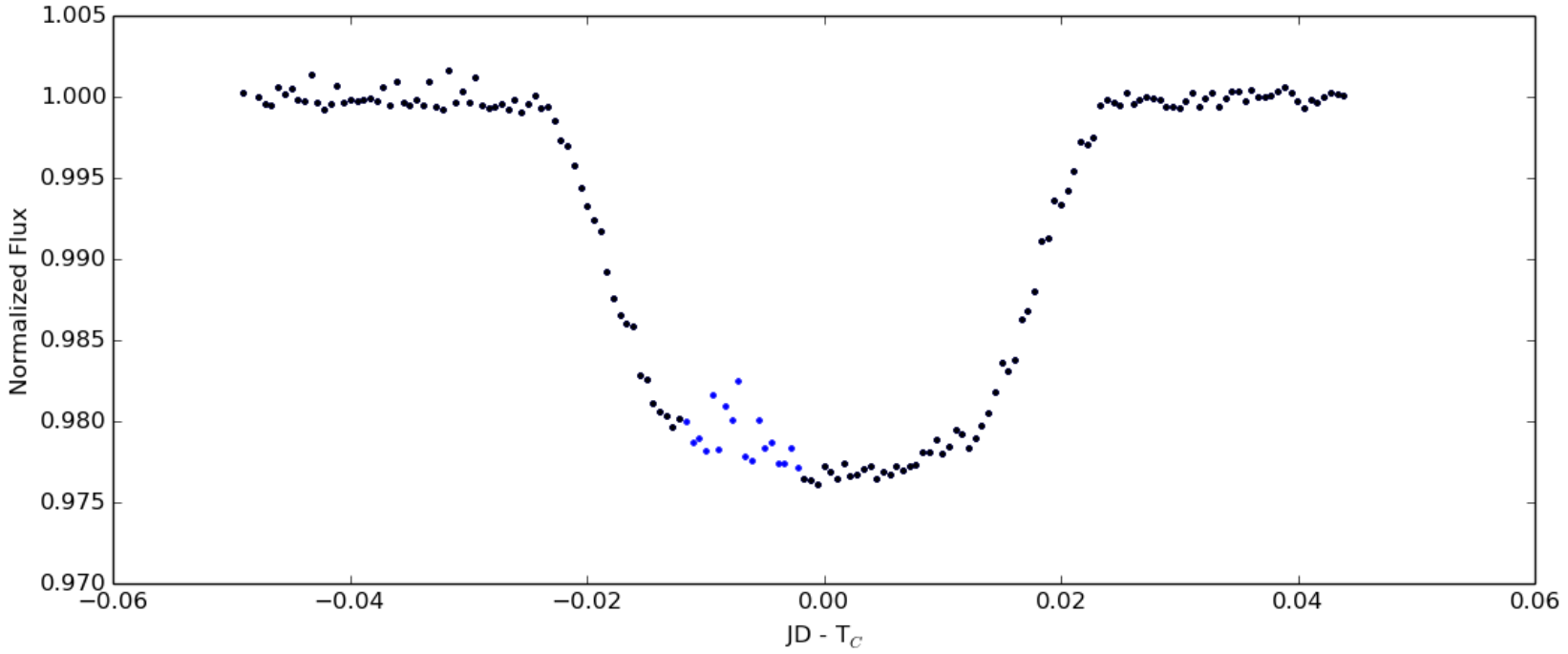


Transmission Spectroscopy with GTC

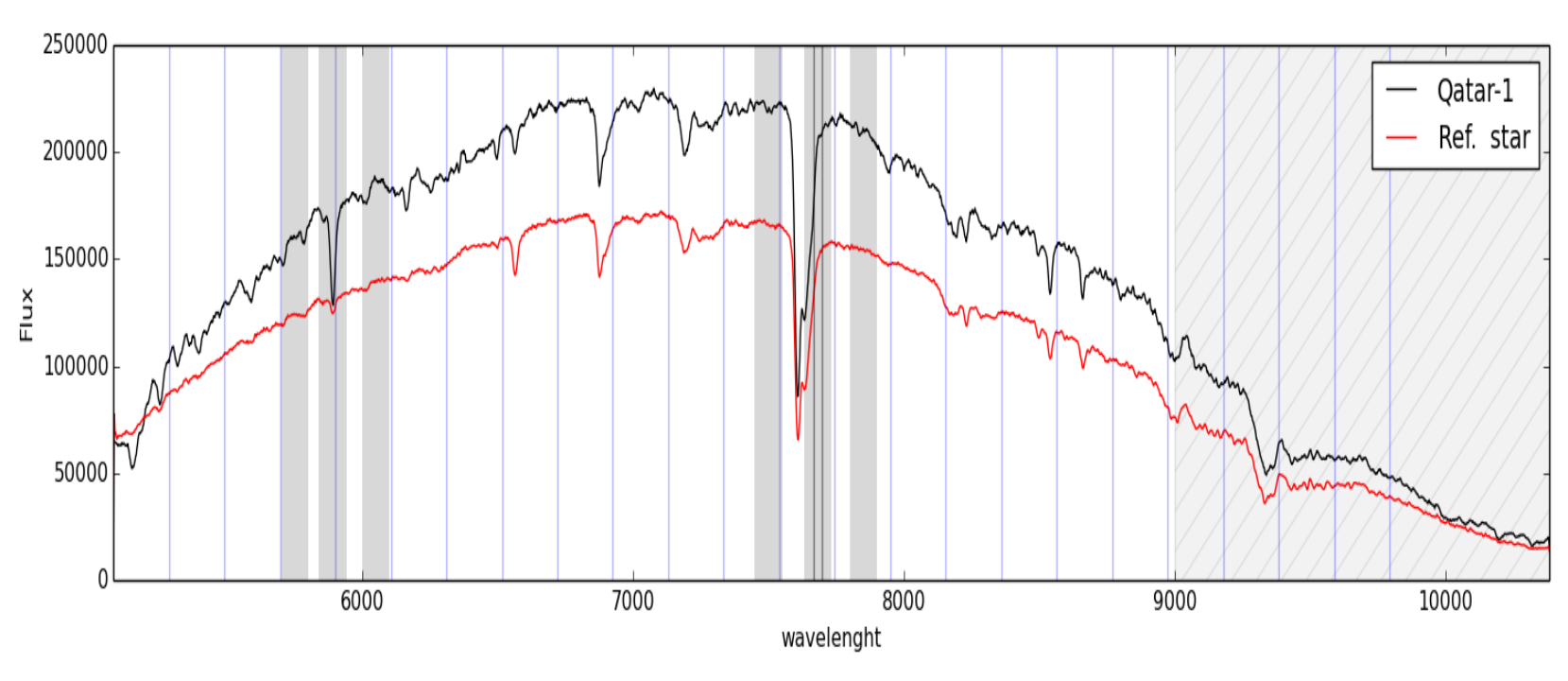


Transmission Spectroscopy with GTC

White light curve (dispersion about 400 ppm)

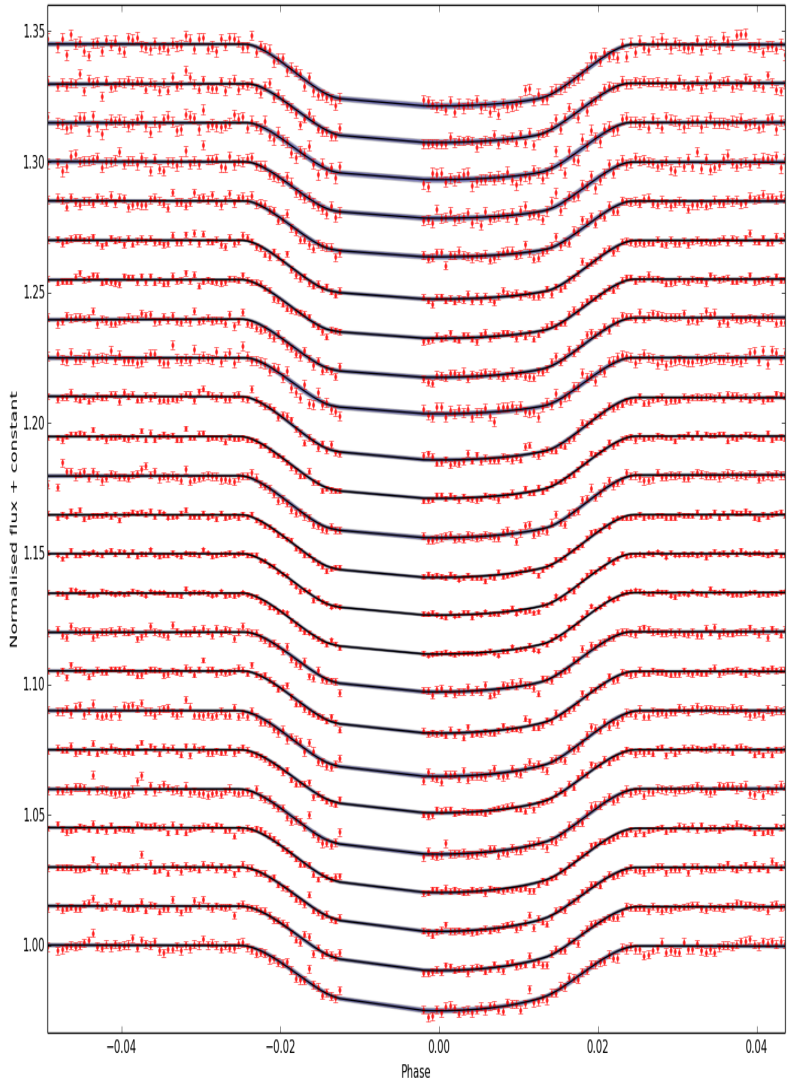


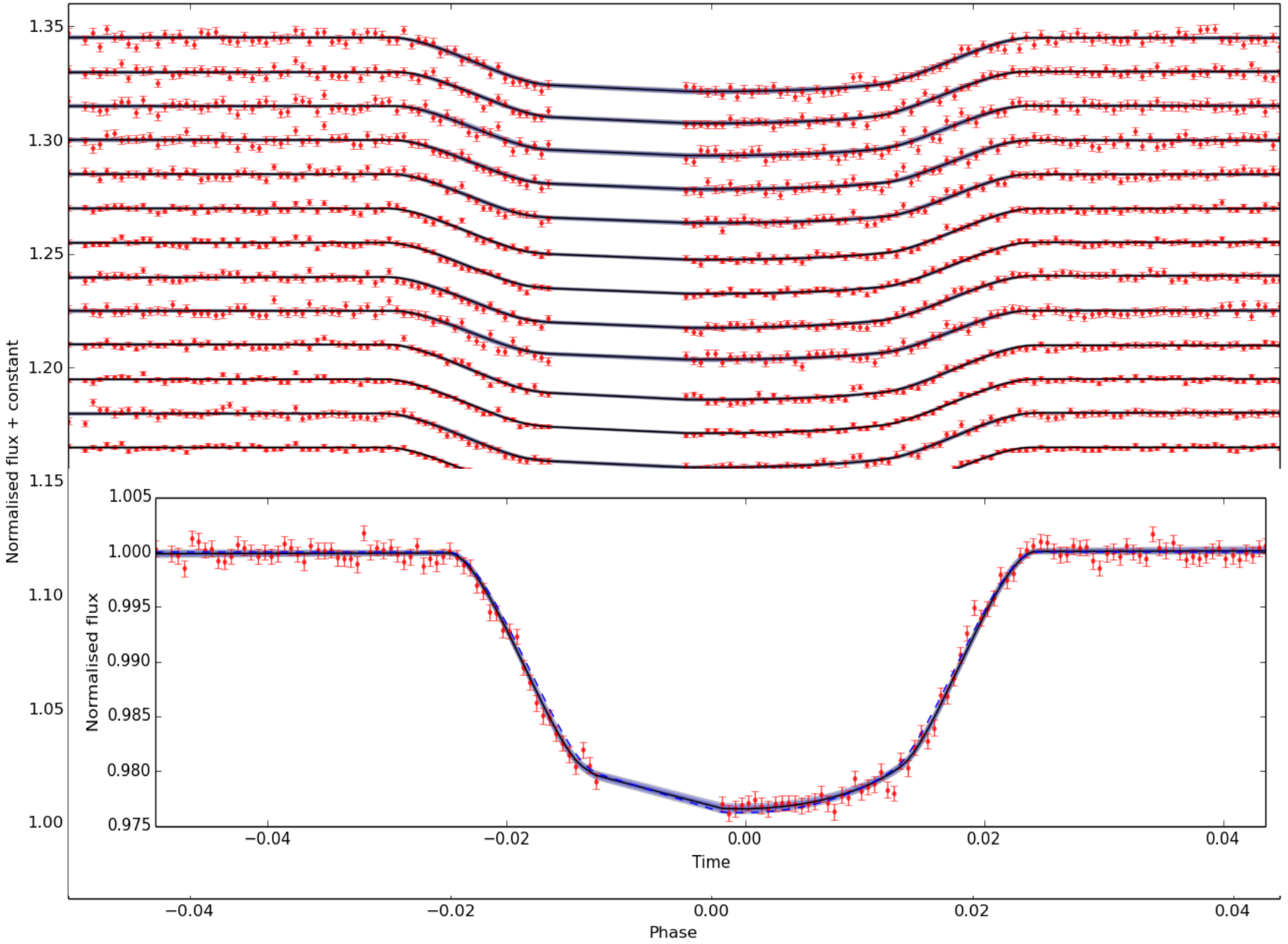
Transmission Spectroscopy with GTC

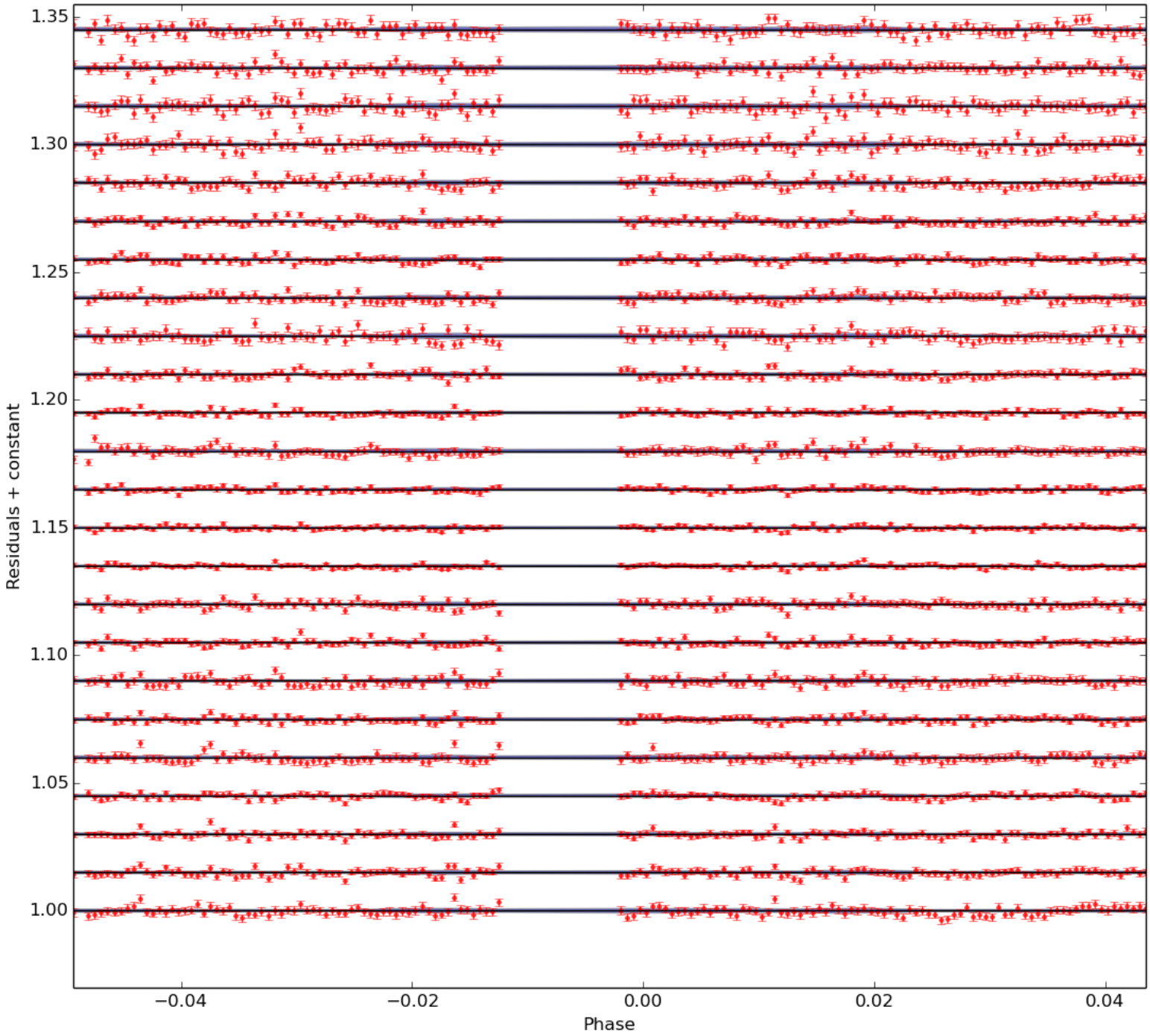


Transmission Spectroscopy with GTC

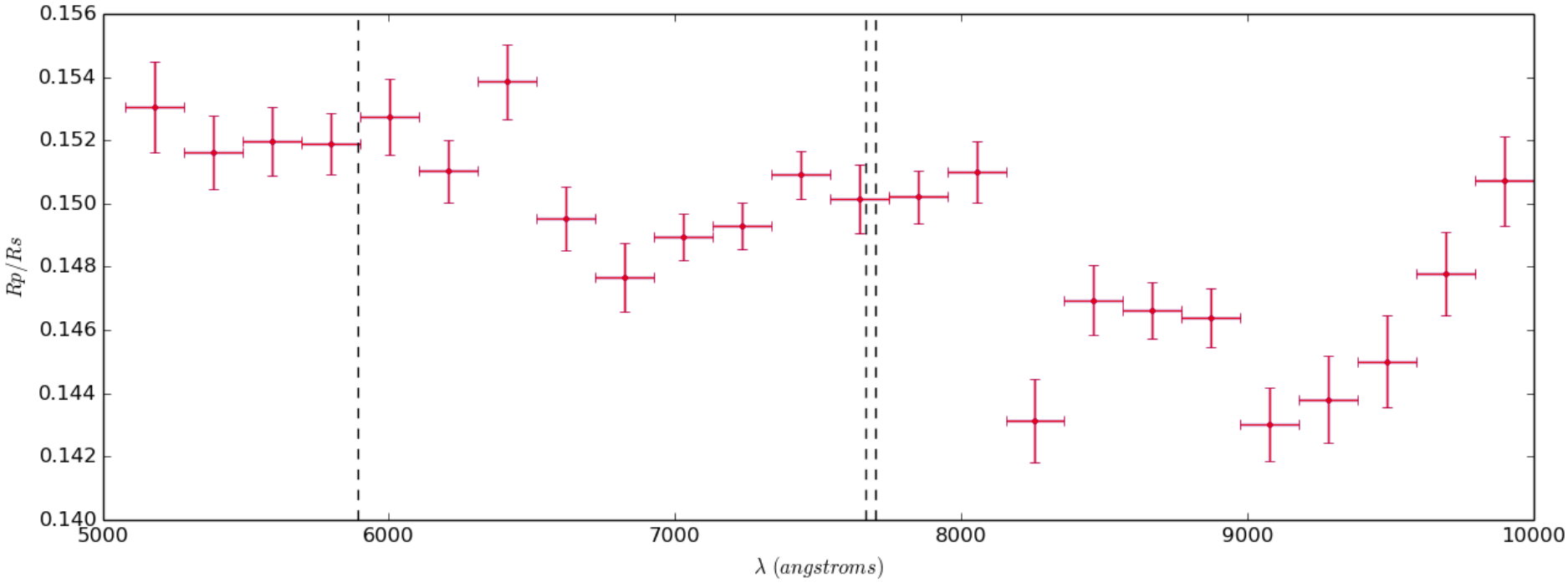
Light curves of the 24 “wide” bands



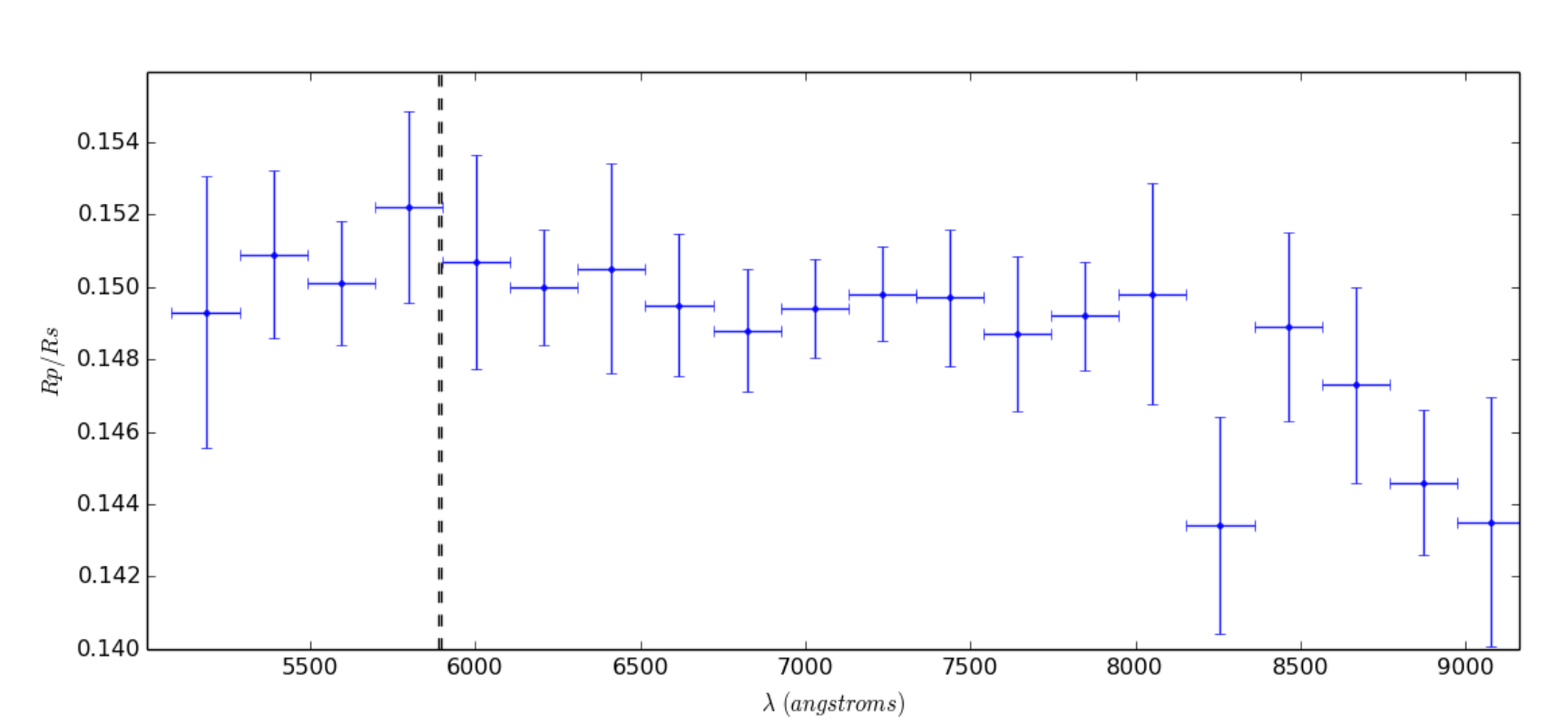

Normalised flux + constant
1.35
1.30
1.25
1.20
1.15
1.10
1.05
1.00
Normalised flux
1.005
1.000
0.995
0.990
0.985
0.980
0.975
−0.04
−0.02
0.00
0.02
0.04
Time
Phase


1.35
1.30
1.25
1.20
1.15
1.10
1.05
1.00
Residuals + constant
−0.04
−0.02
0.00
0.02
0.04
Phase

Qatar-1b transmission spectra
(w/o red noise modelling)

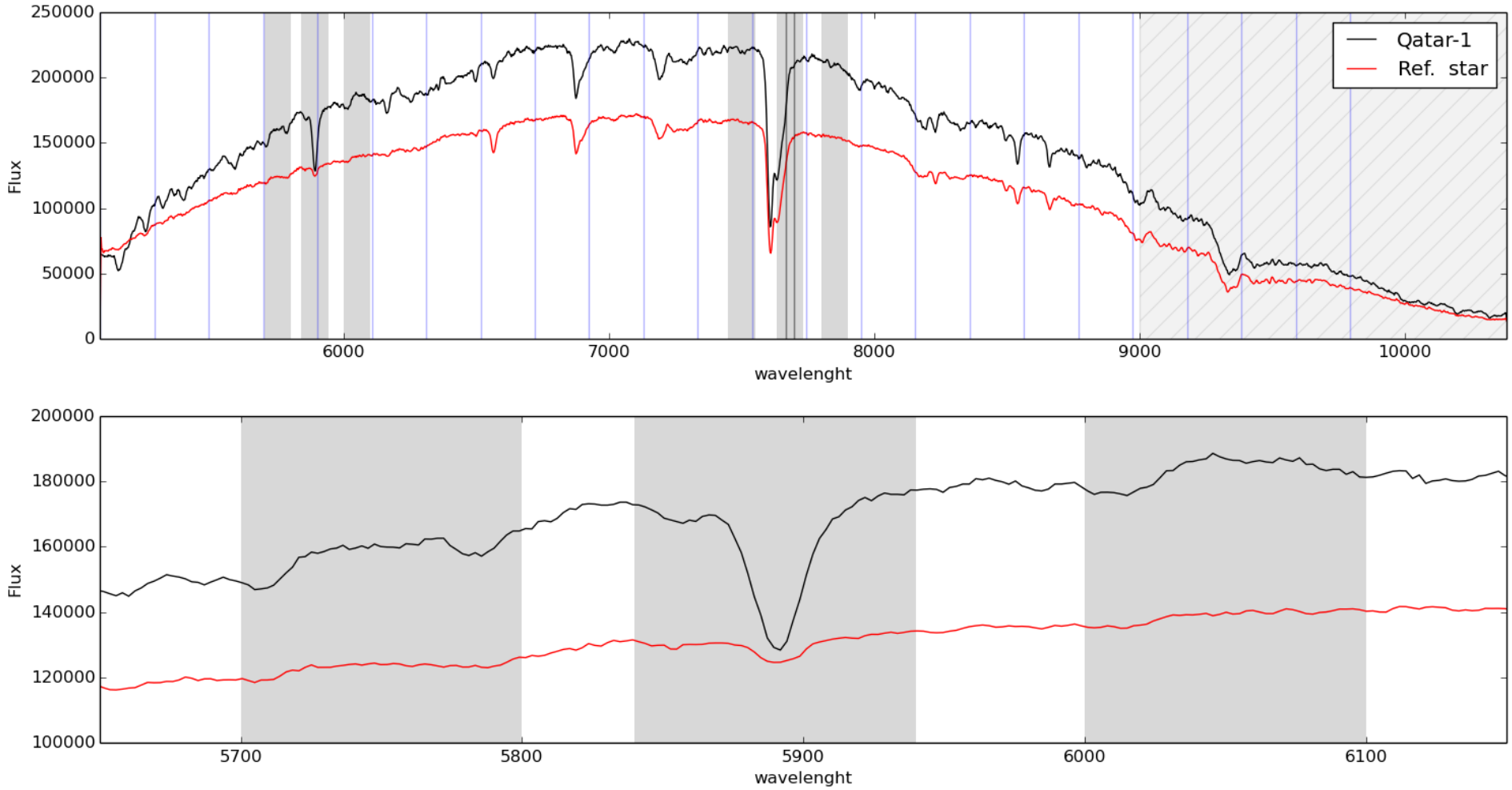


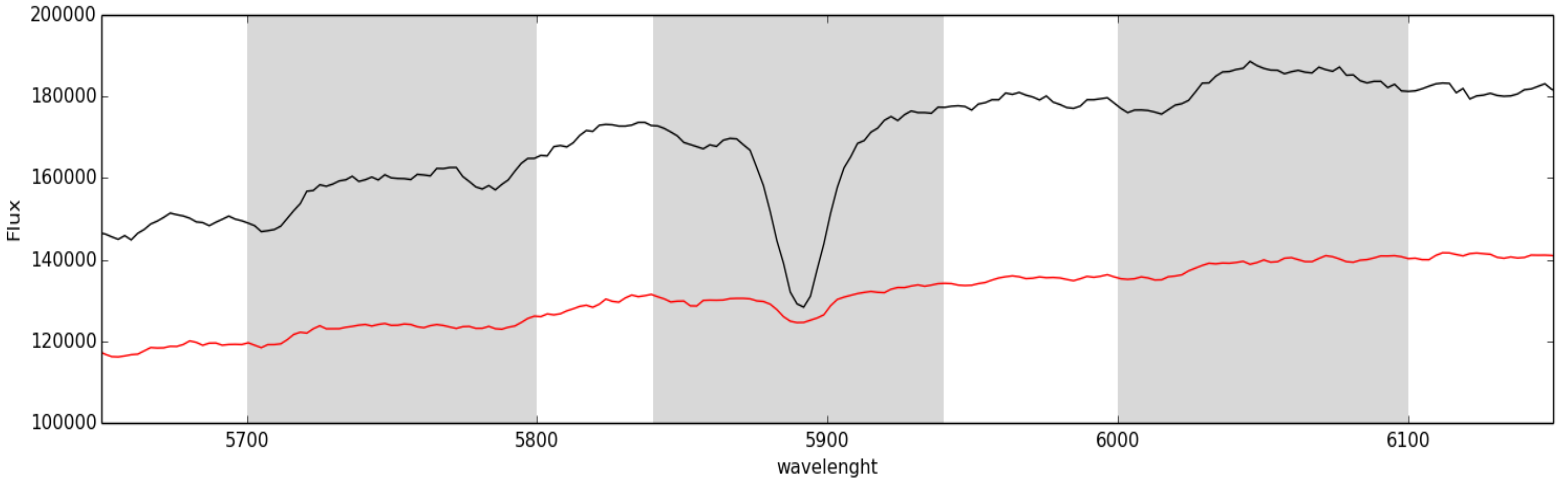
Taking red noise into account

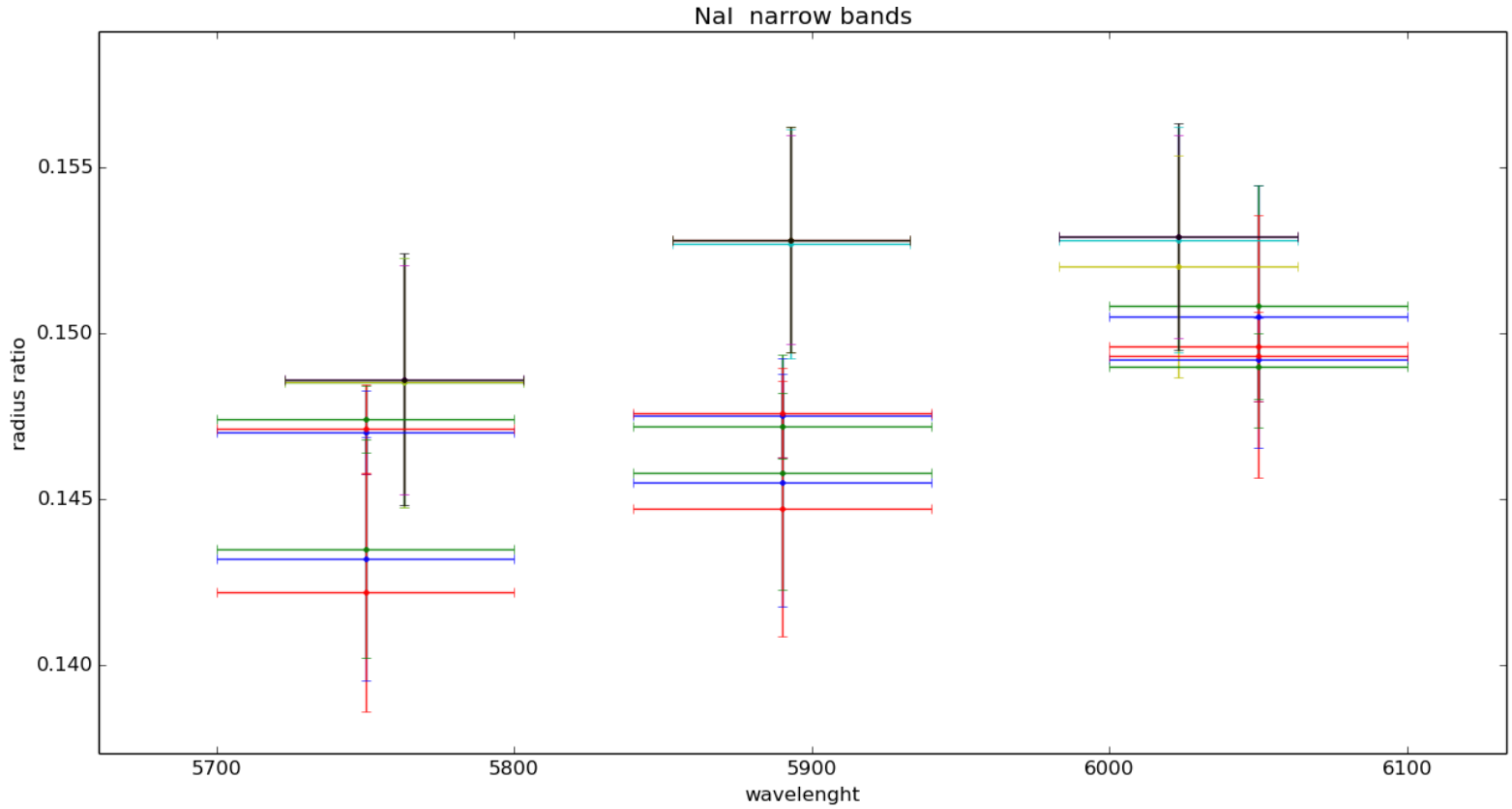


Transmission Spectroscopy with GTC

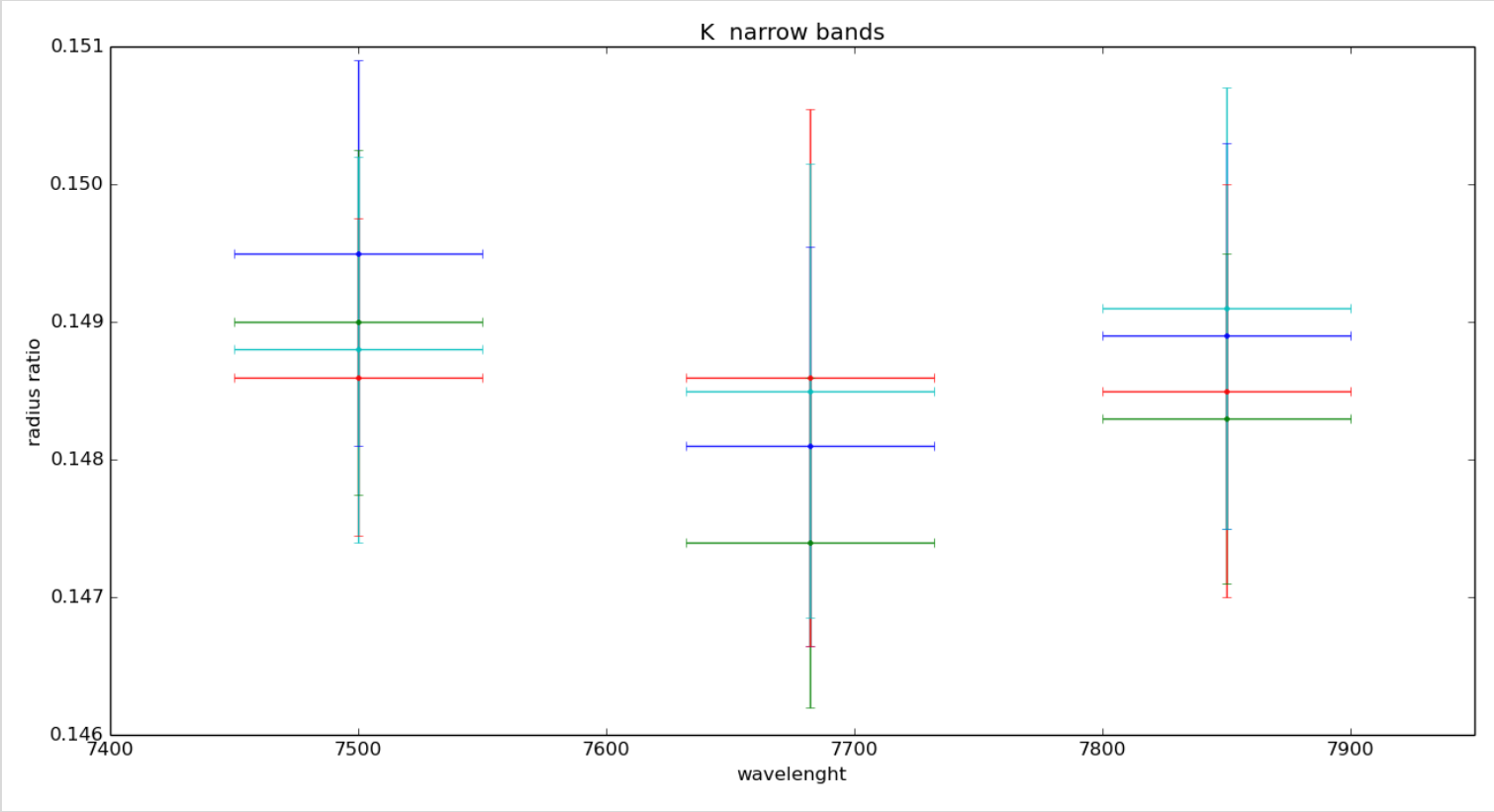
Nal analysis




200000
180000
160000
140000
120000
100000
Flux
5700
5800
5900
6000
6100
wavelenght


NaI narrow bands
0.155
0.150
0.145
0.140
radius ratio
5700
5800
5900
6000
6100
wavelenght

K narrow bands



Summary

GTC is an excellent telescope for exoplanet science, in particular for atmospheric studies.

There is still room for improvement (upgrading pipelines, fine tuning of the complete process, semi-automatization of some steps in the process)

GTC new instrumentation+upgrades in the near future will expand the current capabilities for this type of studies (including near-IR)