# TAPAS : a web-based service of atmospheric transmission computation for astronomy.

**Jean-Loup Bertaux[1], Rosine Lallement[2], Stéphane Ferron[3], Cathy Boonne[4]**

1) LATMOS, UVSQ, CNRS, IPSL
(2) GEPI, Observatoire de Paris
(3) ACRI-ST, Sofia Antipolis/Guyancourt
(4) IPSL

Cnes

TAPAS web site http://ether.ipsl.jussieu.fr/tapas/

Paper: Bertaux et al., Astronomy and Astrophysics, 564, A46 (2014)

HITRAN conference 23-25 June 2014,, Cambridge

TAPAS: Transmissions of the AtmosPhere for AStromomical data

French: Transmission atmosphériques personnalisées pour l'astronomie

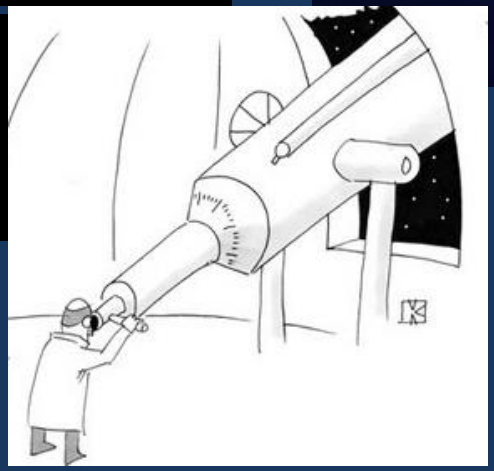
## WHAT TAPAS CAN DO FOR YOU

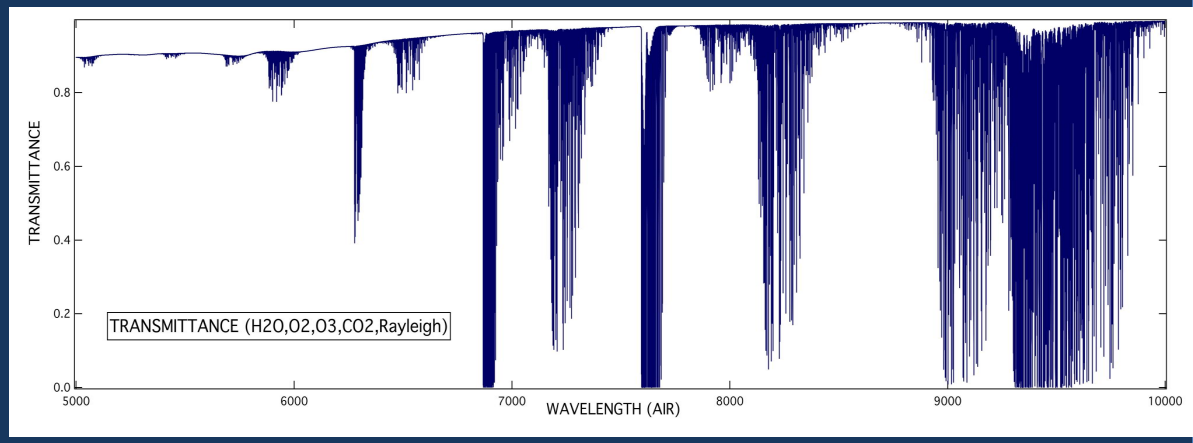
-Make use of the **ETHER**** facility to interpolate within the **ECMWF*** the pressure, temperature, and constituent profile at the location of your observing site and within 6 hours from the date of your observations (with ARLETTY)

-Compute the atmospheric transmittance from the top of the atmosphere down to the observatory, based on the **HITRAN**$ molecular database and the **LBLTRM**$$ **radiative transfer code**

-Provide separate transmittances associated with $H_2O^*$, $O^*_2$, $O^*_3$, $CO_2$, $CH_4$, $N_2O$ and Rayleigh scattering

-Allow disentangling atmospheric features from other absorptions in your astronomical spectra






ACRI ST

cnrs

LATMOS

l'Observatoire de Paris — GEPI

ETHER

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***ECMWF: European Centre for Medium-Range Weather Forecasts**

**ETHER: Centre for Atmospheric Chemistry Products and Services

$**HITRAN: hi**gh-resolution **tran**smission molecular absorption database

$$**LBLTRM:** Line-By-Line Radiative Transfer Model

# ETHER WEB Page

Ether

## Atmospheric Chemistry Data Centre

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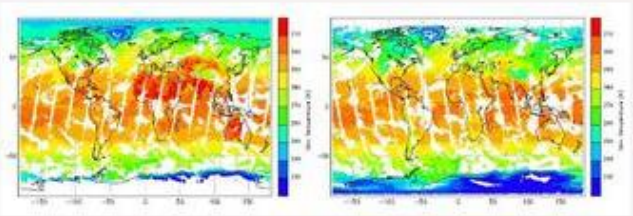
### News

Project call
May 2014 : MOZAIC-IAGOS symposium
June 2014 : GEISA Workshop : spectroscopic databases
8-10 september 2014 : ADOMOCA-3 Workshop



IASI skin temperature map from Metop-B on April 10

**Atmospheric Data** - Satellites - Balloons - NDACC - ECCAD - IASI - GOSAT - IAGOS

| Satellites | Balloons | NDACC | ECCAD | IASI | GOSAT | IAGOS |
|---|---|---|---|---|---|---|
|  |  |  |  |  |  |  |

- **Field Campaigns** - TROpico - Megapoli - Enriched - StrapolEte - Malicca
- **Daily Modelisation and Forecast** - Mimosa - Reprobus - Acomida
- **Spectroscopic data and Kinetics** - GEISA - Kinetics - IUPAC
- **Tools** - Arletty - Girafe - Tapas - Software
- **Outreach** - Omer 7A - Specatmo - HIResMIR - Documentation

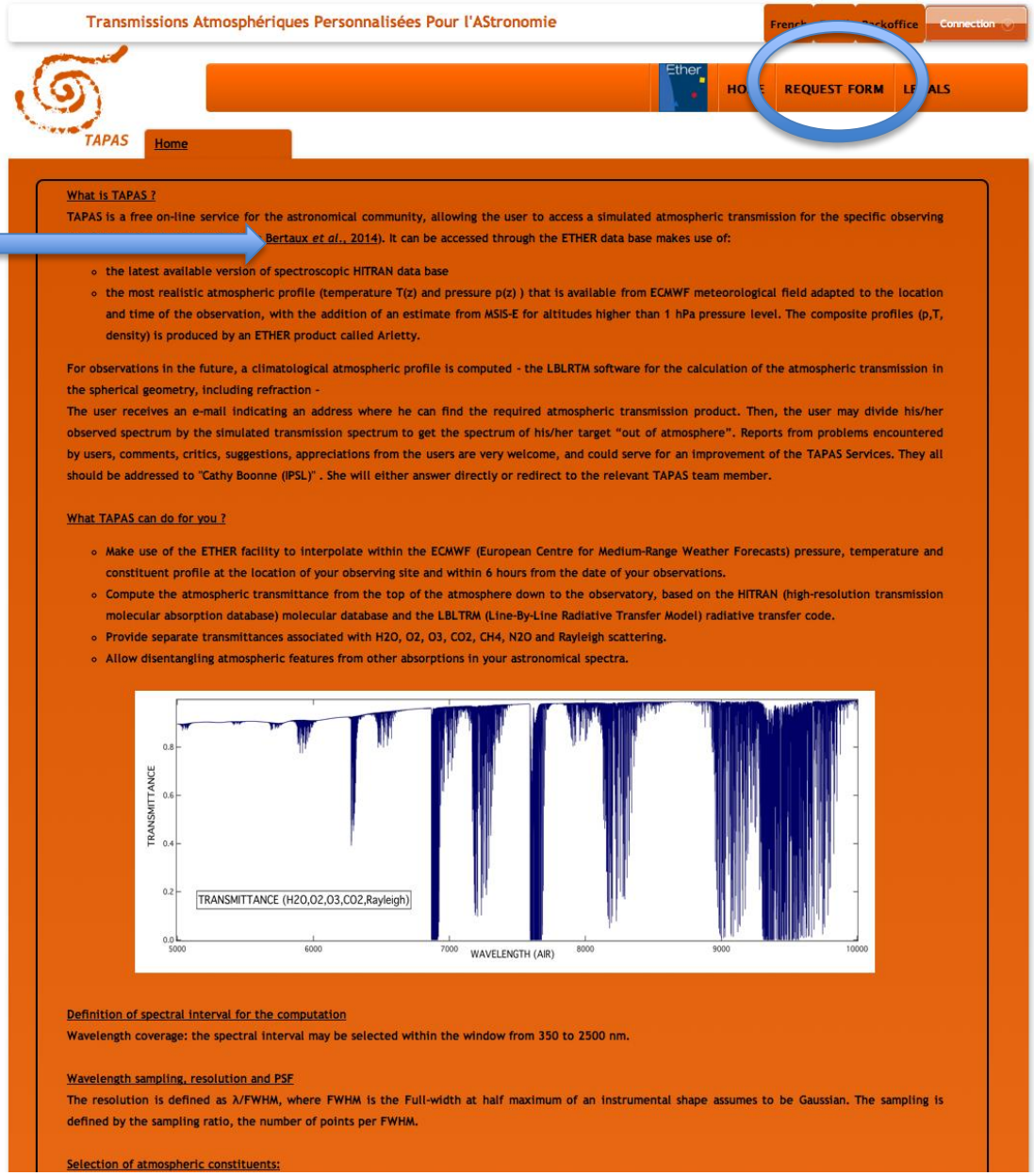
Last update : 2014/05/19

Project call | Legals | Contacts

Institut Pierre Simon Laplace | OMP | cnes | cnrs INSU | SATMOS | ICARE

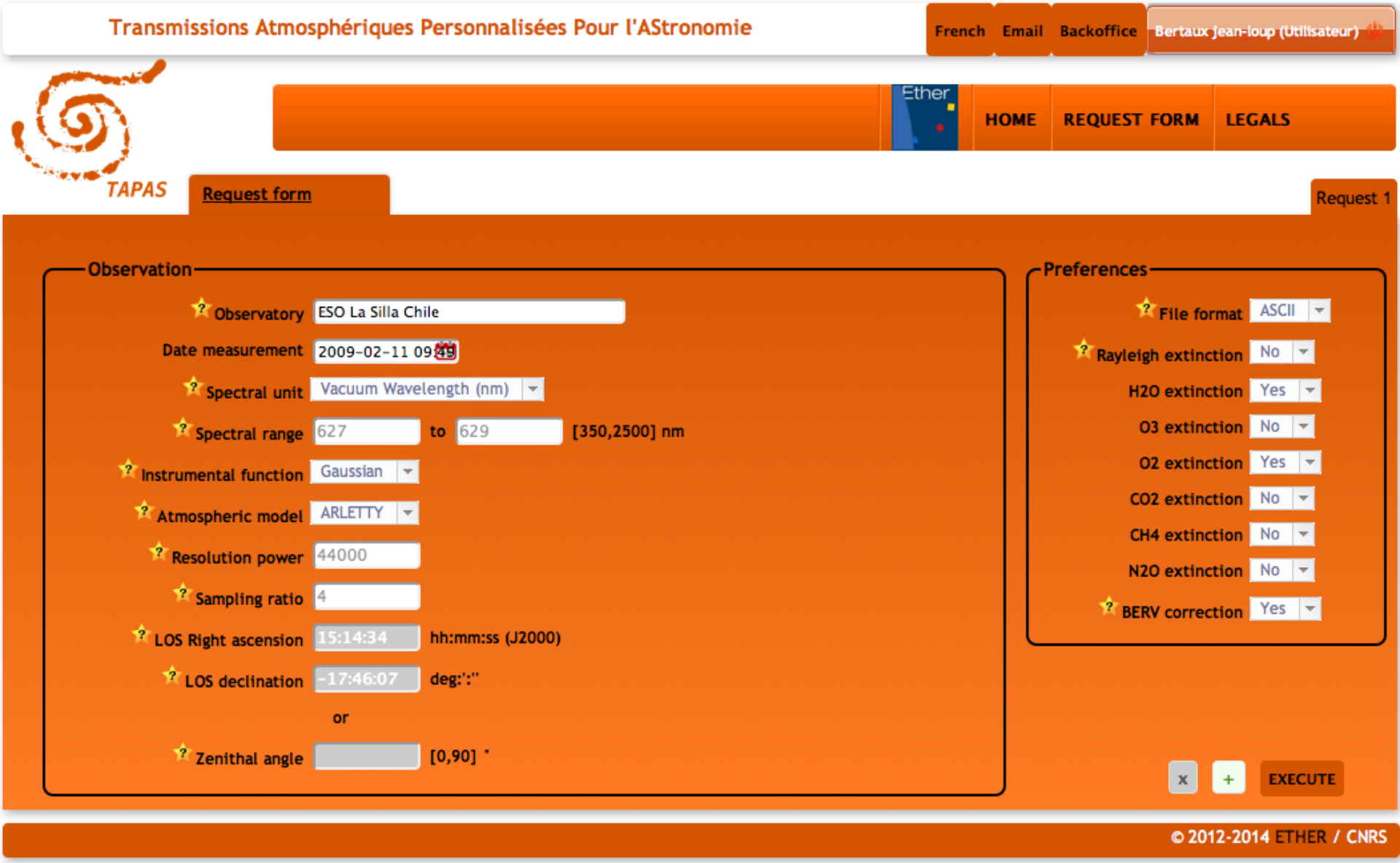
# TAPAS WEB Page

click here to get the TAPAS paper

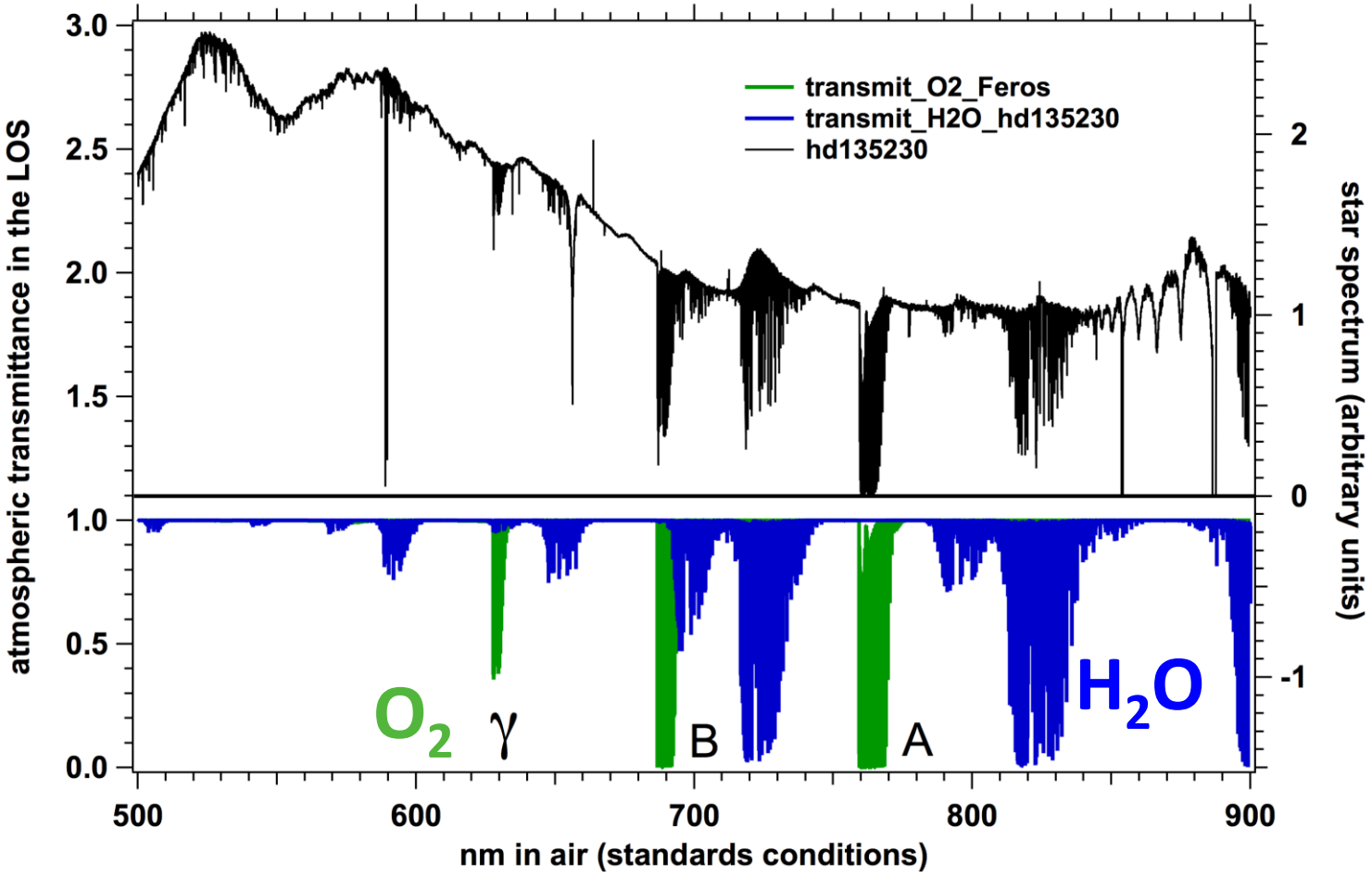



TAPAS web site http://ether.ipsl.jussieu.fr/tapas/

# TAPAS REQUEST FORM page

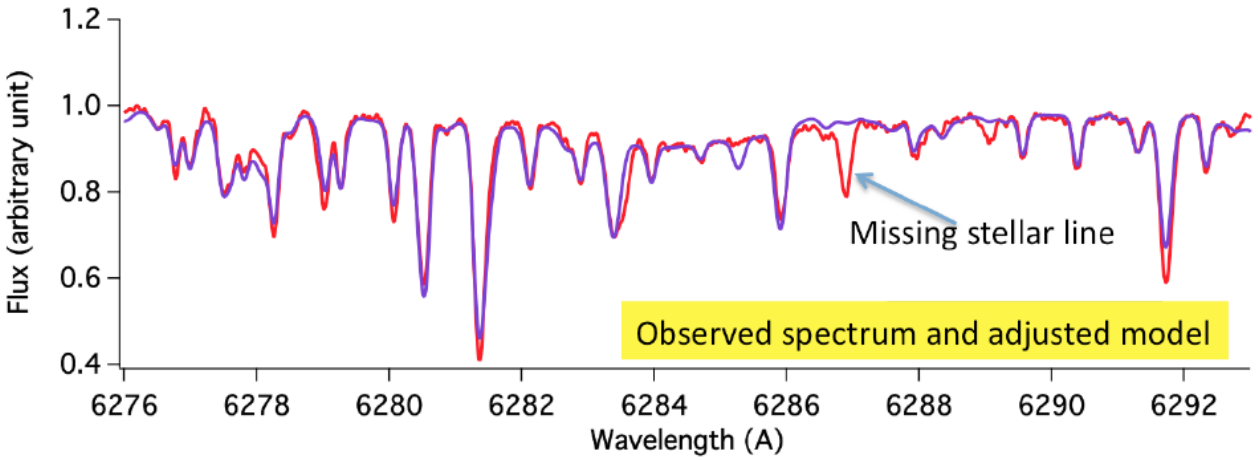


# Hot star spectrum dominated by telluric absorption



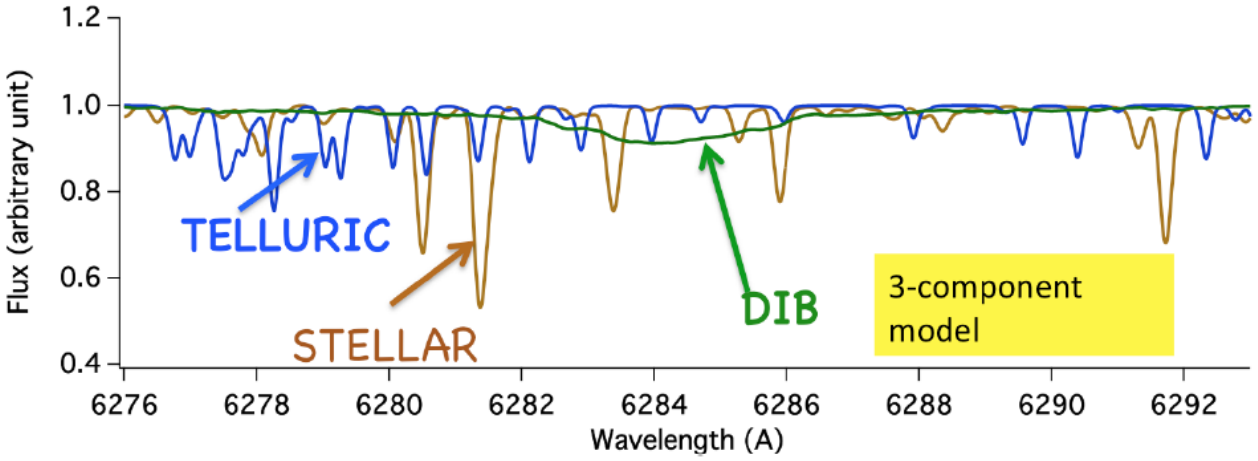
# Identification of absorption source

Fiiting an observed star spectrum (red) by a combination of three models:



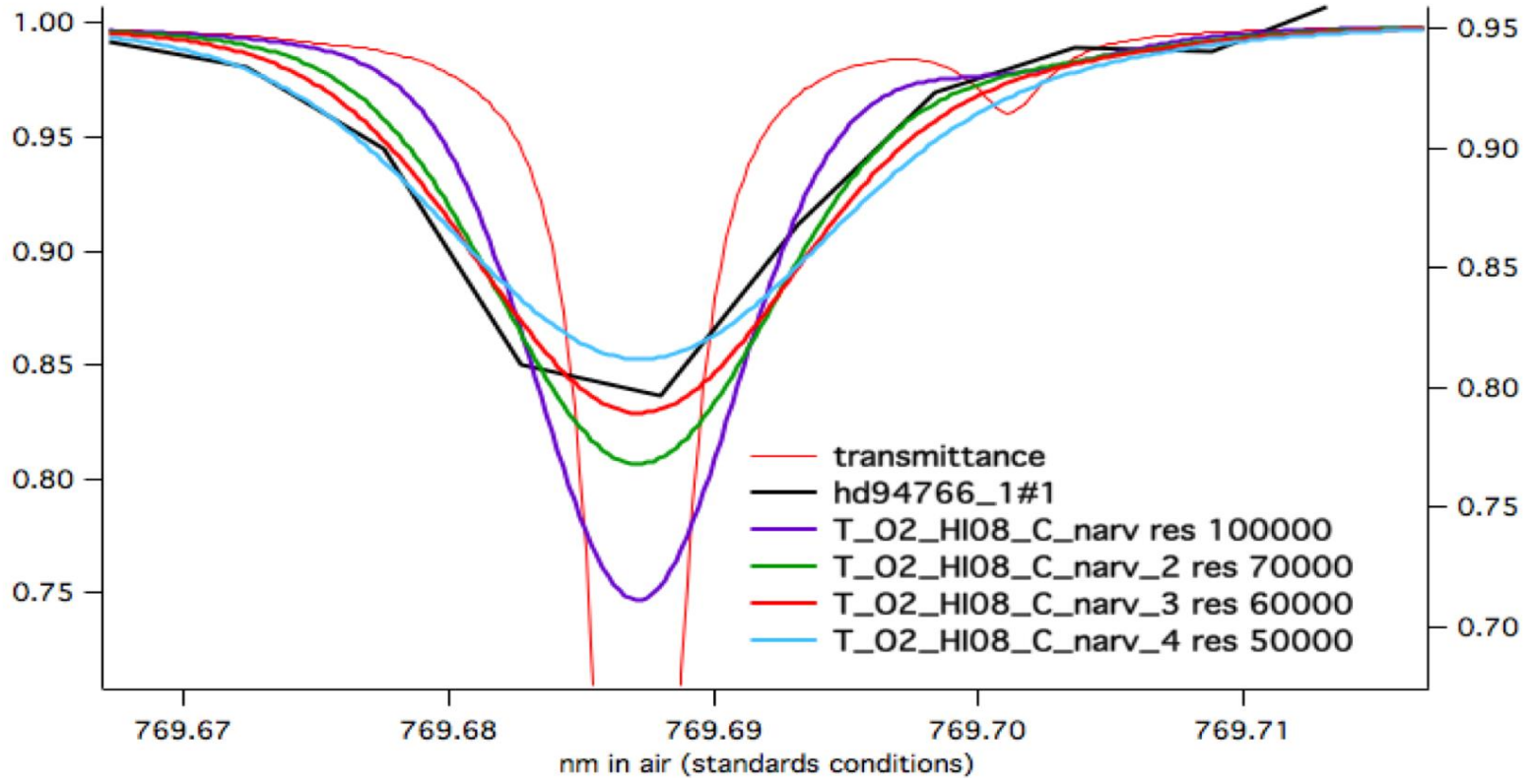

- **intrinsic stellar lines**
- **telluric absorption:TAPAS**
- **interstellar absorption:**

**DIB, Diffuse Interstellar Band (PAH?) Polcyclic aromatics, ≈ $C_{24}H_3$?**




Spectral Shape of DIB known. Absolute quantity is determined from fitting

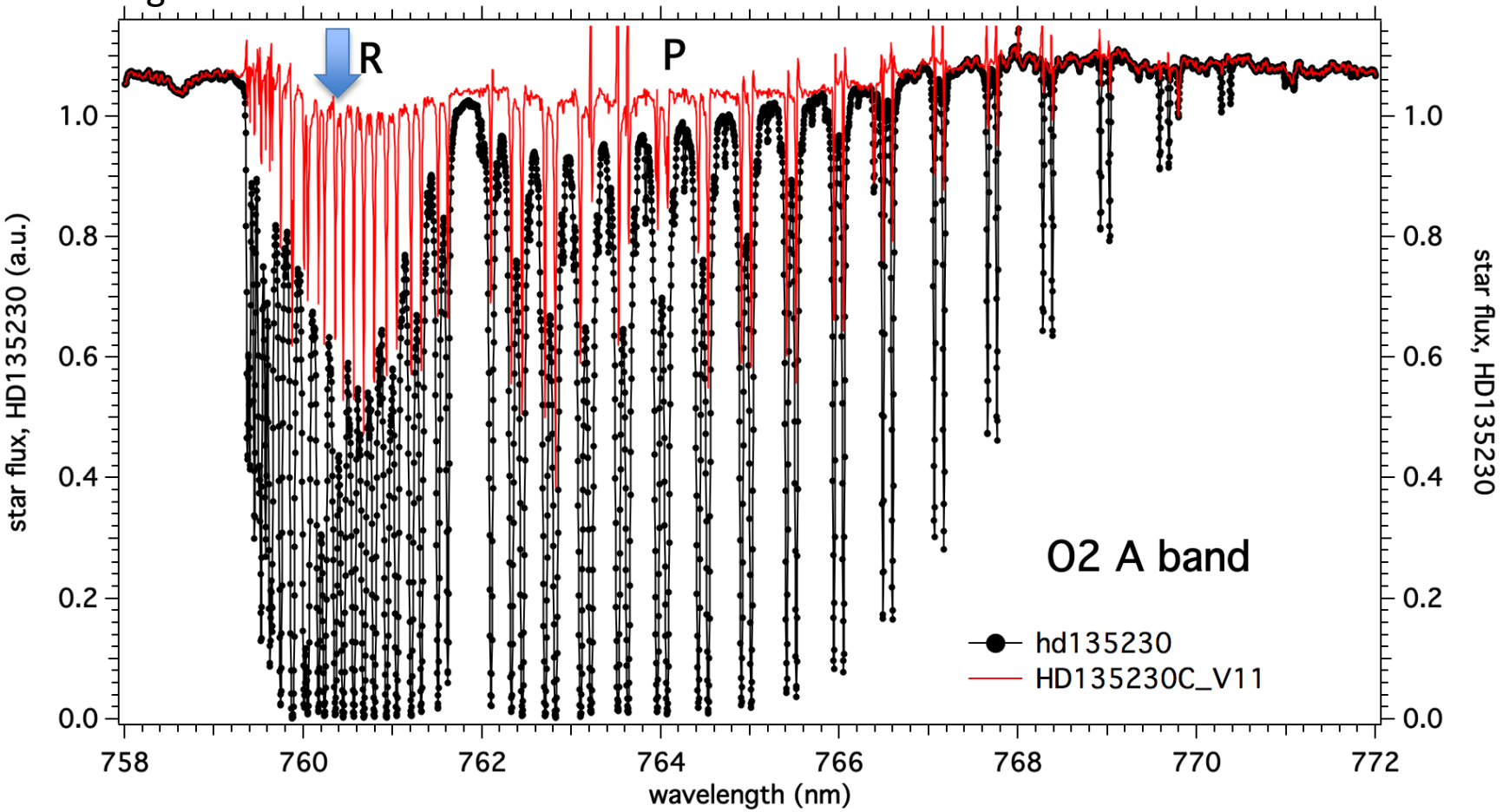
# Finding the actual spectrometer resolution and ILSF (Instrument Line Spread Function)




- **Profile eye comparison**
- **Deconvolution of observed single line profile by TAPAS highest spectral resolution**

# Correction of star spectrum by division of atmospheric transmission : The atmospheric A band ($O_2$)

CIA: Collision Induced absorption still missing in TAPAS but not in HITRAN 2012



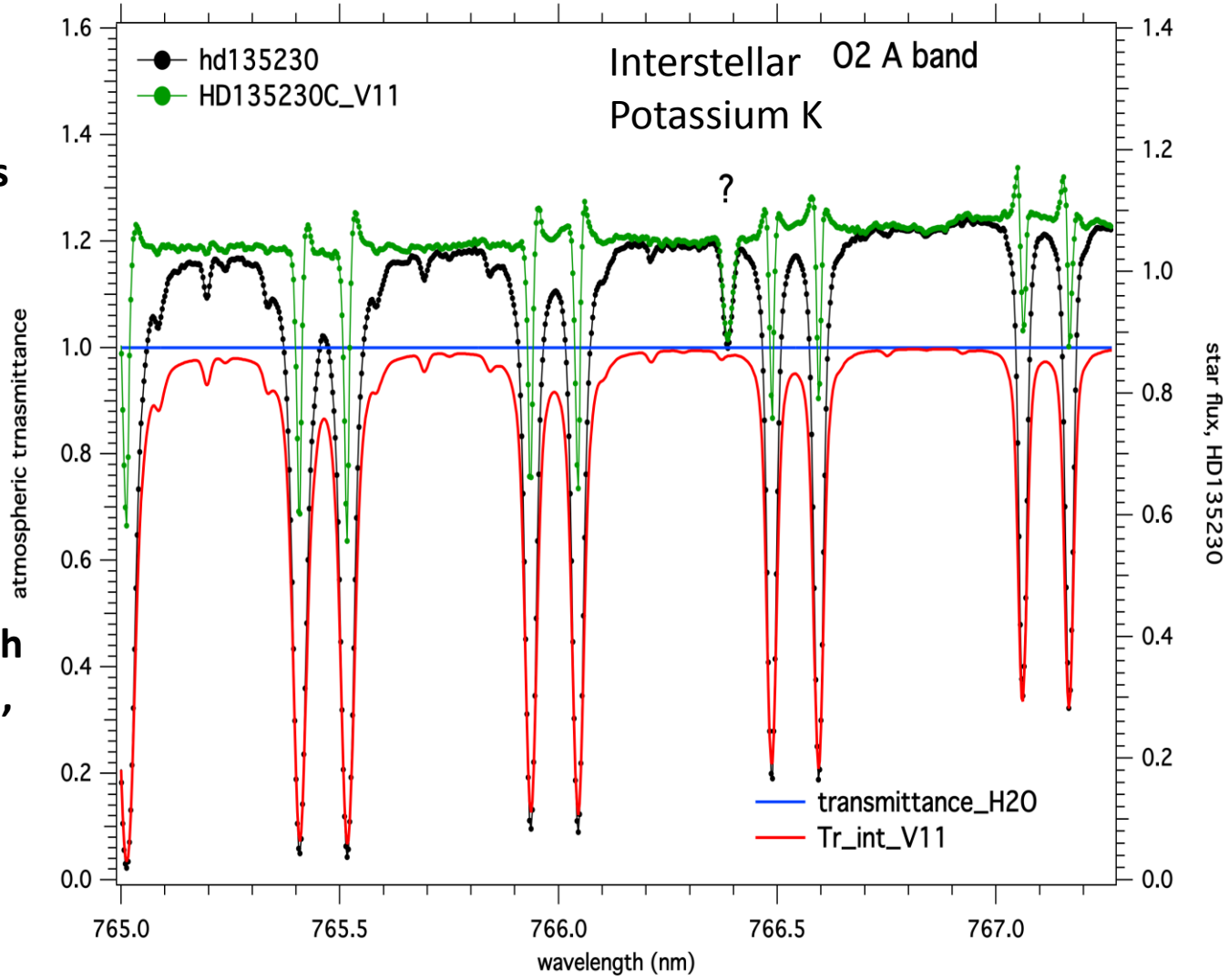
# Retrieving star spectrum by division of atmospheric transmission

**Retrieval OK except Line center where retrieval is spurious: no info when signal is 0**

**Wavelength shift is variable! P Cygni profile**

**This FEROS/La Silla spectrometer wavelength calibration is not perfect,**

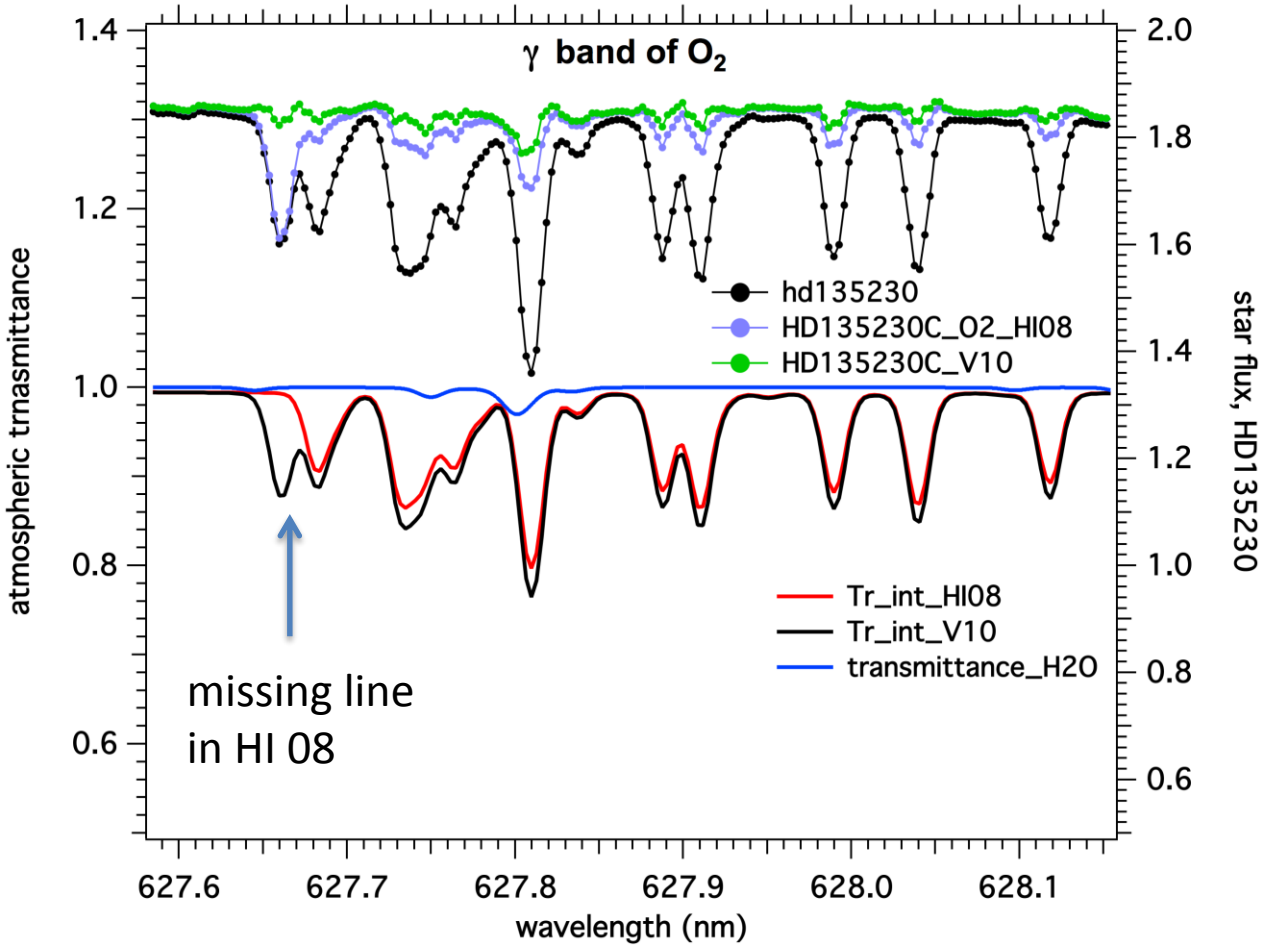
**A simple shift is not enough**



# Improving spectroscopy

dividing one hot star spectrum by two TAPAS simulations:

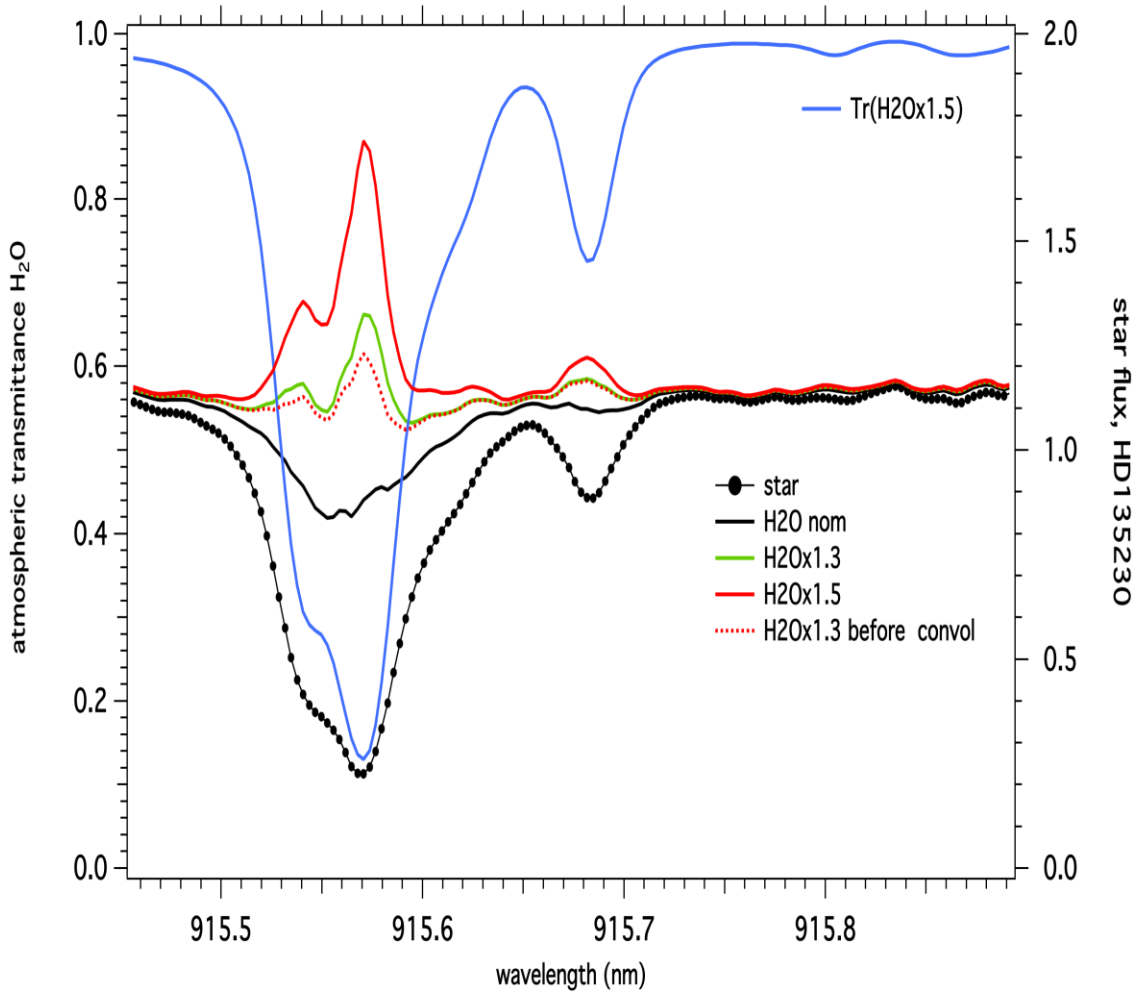
Comparing HITRAN 2008 and improved release (Gordon 2010) V10 now in HITRAN 2012



# Finding the actual $H_2O$ column

**-ECMWF/TAPAS H2O nominal is not enough**

- **$T^X(H_2O)$**
- **X=1.3, 1.5, X: multiplicative factor for the whole $H_2O$ column**
- **Finding: X seems to vary from line to line, even in nearby wavelengths**
- **Problem of spectroscopy ?**
- **Or atmospheric profile P(z), T(z), H2O (z)?**

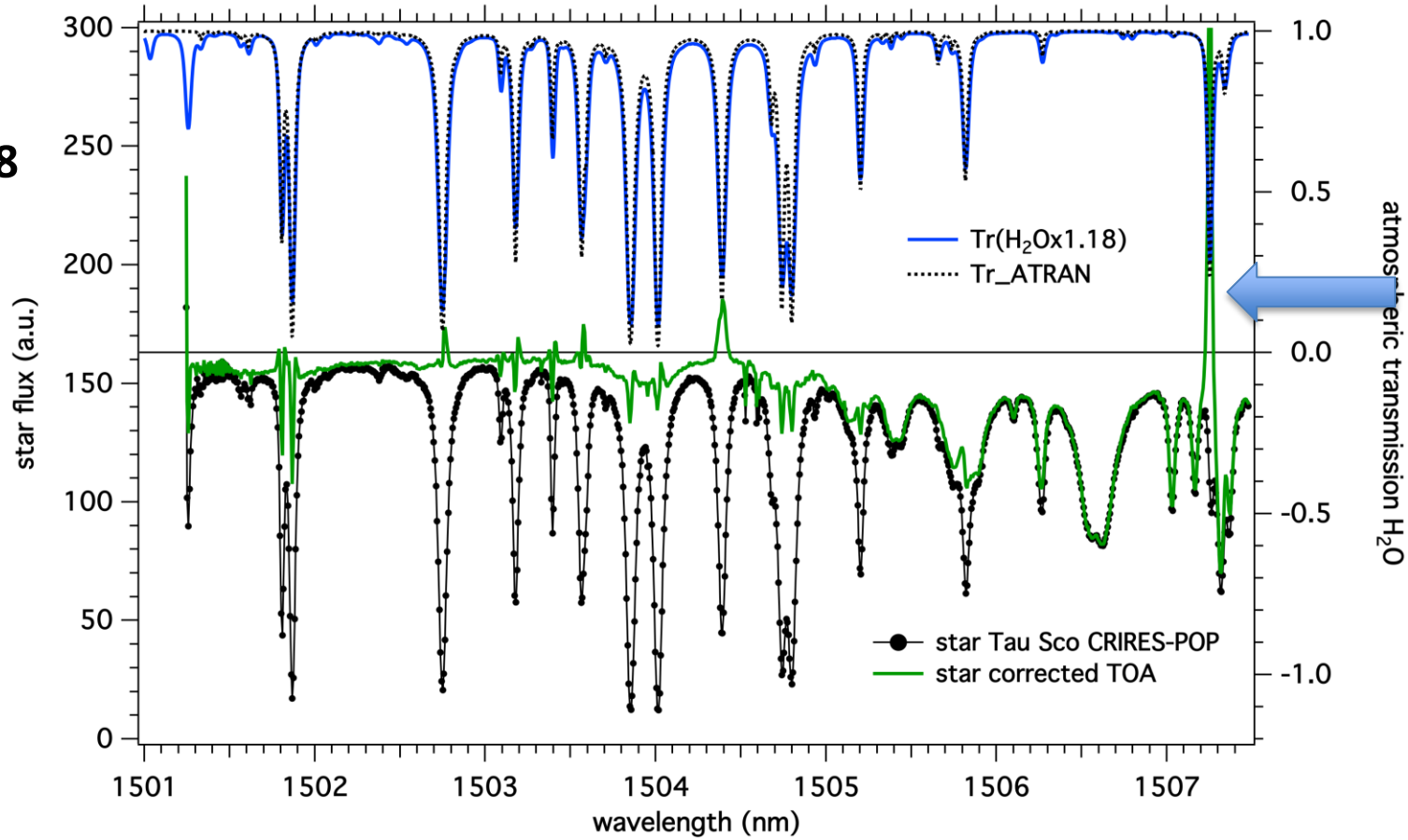



**This question will be solved from the study of numerous star spectra compared to TAPAS !**

# Near IR $H_2O$: CRIRES/ VLT/ESO

**$H_2O$ nom has to be scaled X=1.18**

**$T^{1.18}(H_2O)$**




**Some line strengths are overestimated in Hitran 2008**
**Factor 5 for 1507.25 nm = 6634.60 $cm^{-1}$**

**Much better now with HITRAN 2012**

The temperature dependence linewidth parameter (air broadening) was negative (-0.22) in HI08 and is +0.43 in HITRAN 2012 (Larry Rothman dixit, March 2014)

# Table 1 (Rothman et al., 2013)

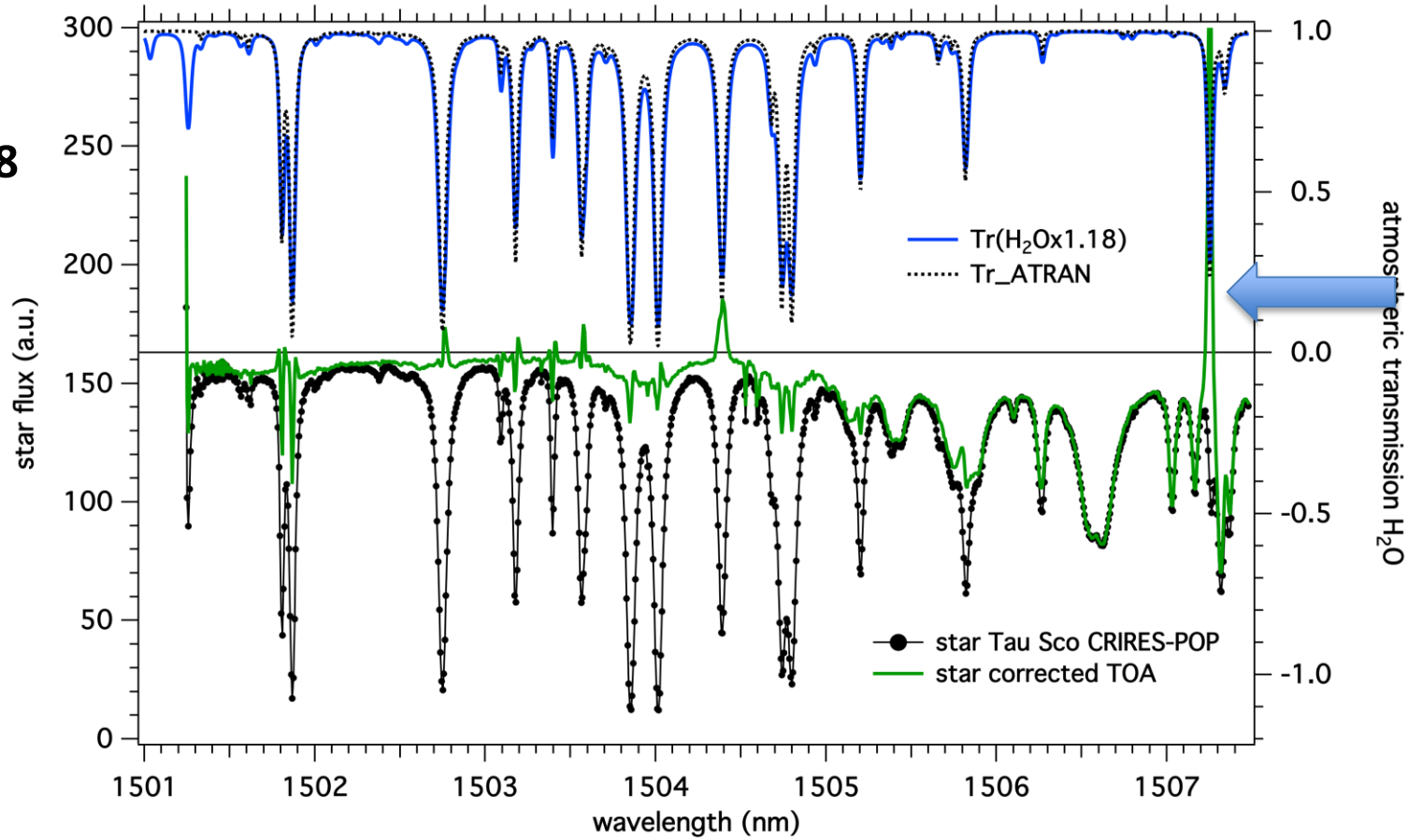
**Table 1**
Description of the quantities present in the 160-character records (transitions) of the line-by-line portion of the HITRAN database.

| Parameter | Meaning | Field length | Type | Comments or units |
|---|---|---|---|---|
| $M$ | Molecule number | 2 | Integer | HITRAN chronological assignment |
| $I$ | Isotopologue number | 1 | Integer | Ordering by terrestrial abundance |
| $\nu$ | Vacuum wavenumber | 12 | Real[a] | $cm^{-1}$ |
| $S$ | Intensity | 10 | Real[a] | $cm^{-1}$/(molecule $cm^{-2}$) at standard 296 K |
| $A$ | Einstein-$A$ coefficient | 10 | Real | $s^{-1}$ |
| $\gamma_{air}$ | Air-broadened half width | 5 | Real | HWHM at 296 K (in $cm^{-1}$ $atm^{-1}$) |
| $\gamma_{self}$ | Self-broadened half width | 5 | Real | HWHM at 296 K (in $cm^{-1}$ $atm^{-1}$) |
| $E''$ | Lower-state energy | 10 | Real | $cm^{-1}$ |
| $n$ | Temperature-dependence coefficient | 4 | Real | Temperature-dependent exponent for $\gamma_{air}$ |
| $\delta$ | Air pressure-induced line shift | 8 | Real | $cm^{-1}$ $atm^{-1}$ at 296 K |
| $V'$ | Upper-state "global" quanta | 15 | Character | See Table 3 in Ref. [2] |
| $V''$ | Lower-state "global" quanta | 15 | Character | See Table 3 in Ref. [2] |
| $Q'$ | Upper-state "local" quanta | 15 | Character | See Table 4 in Ref. [2] |
| $Q''$ | Lower-state "local" quanta | 15 | Character | See Table 4 in Ref. [2] |
| Ierr | Uncertainty indices | 6 | Integer | Accuracy for 6 critical parameters ($\nu$, $S$, $\gamma_{air}$, $\gamma_{self}$, $n$, $\delta$), see Table 5 of Ref. [2] |
| Iref | Reference indices | 12 | Integer | References for 6 critical parameters ($\nu$, $S$, $\gamma_{air}$, $\gamma_{self}$, $n$, $\delta$) |
| * | Flag | 1 | Character | Pointer to program and data for the case of line mixing |
| $g'$ | Statistical weight of upper state | 7 | Real | See details in Ref. [3] |
| $g''$ | Statistical weight of lower state | 7 | Real | See details in Ref. [3] |

# Near IR $H_2O$: CRIRES/ VLT/ESO

**$H_2O$ nom has to be scaled X=1.18**

**$T^{1.18}(H_2O)$**

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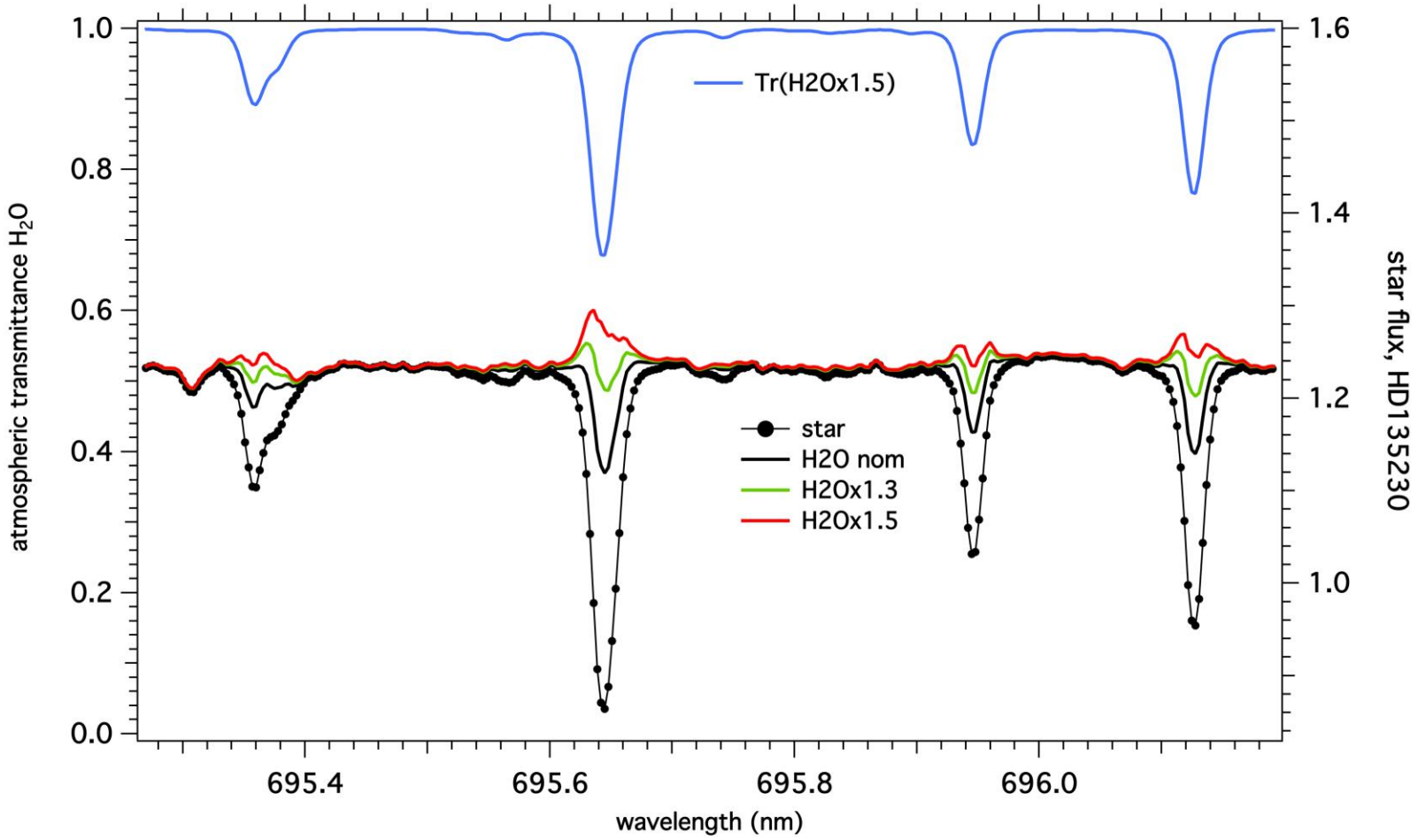
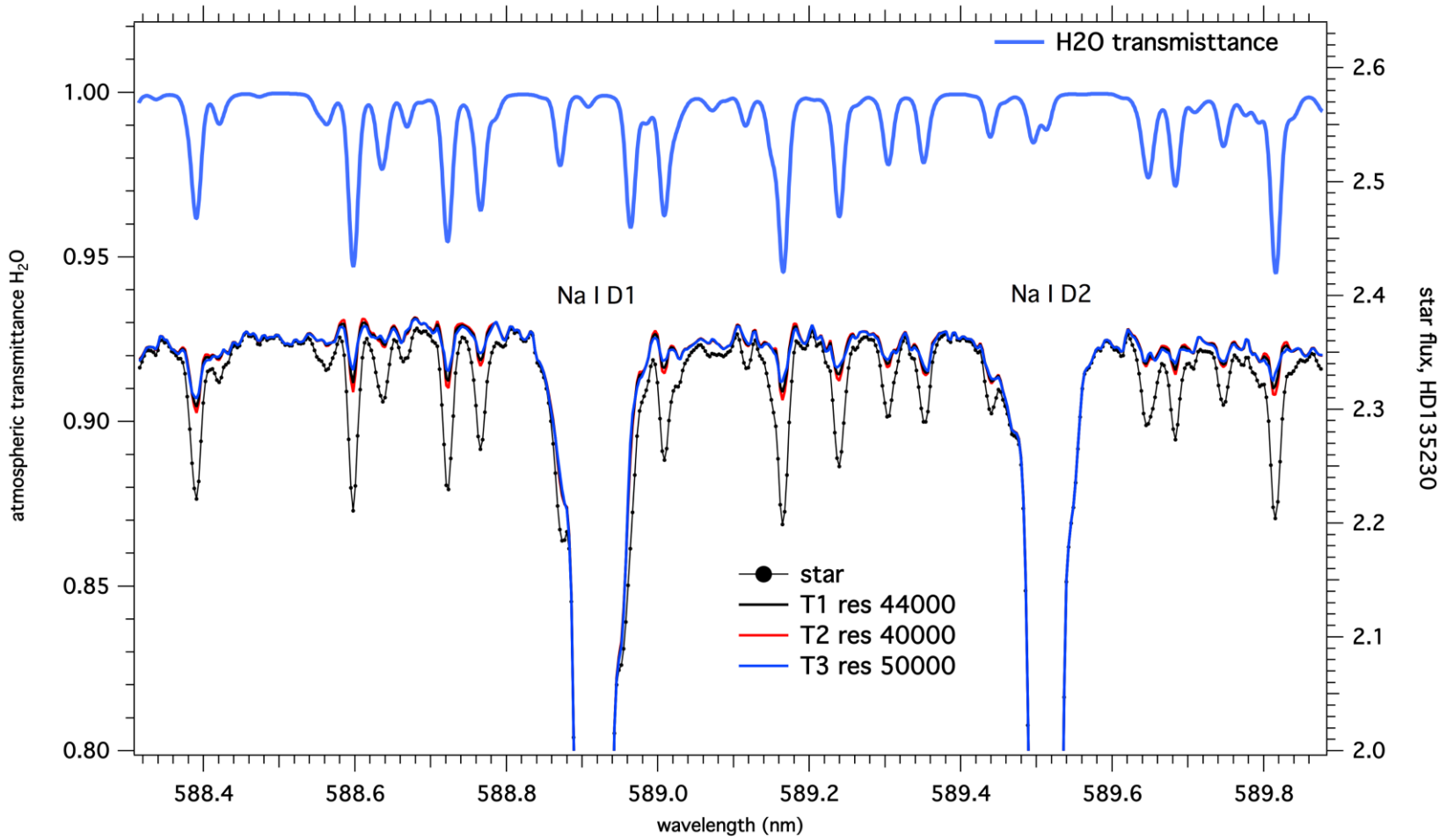
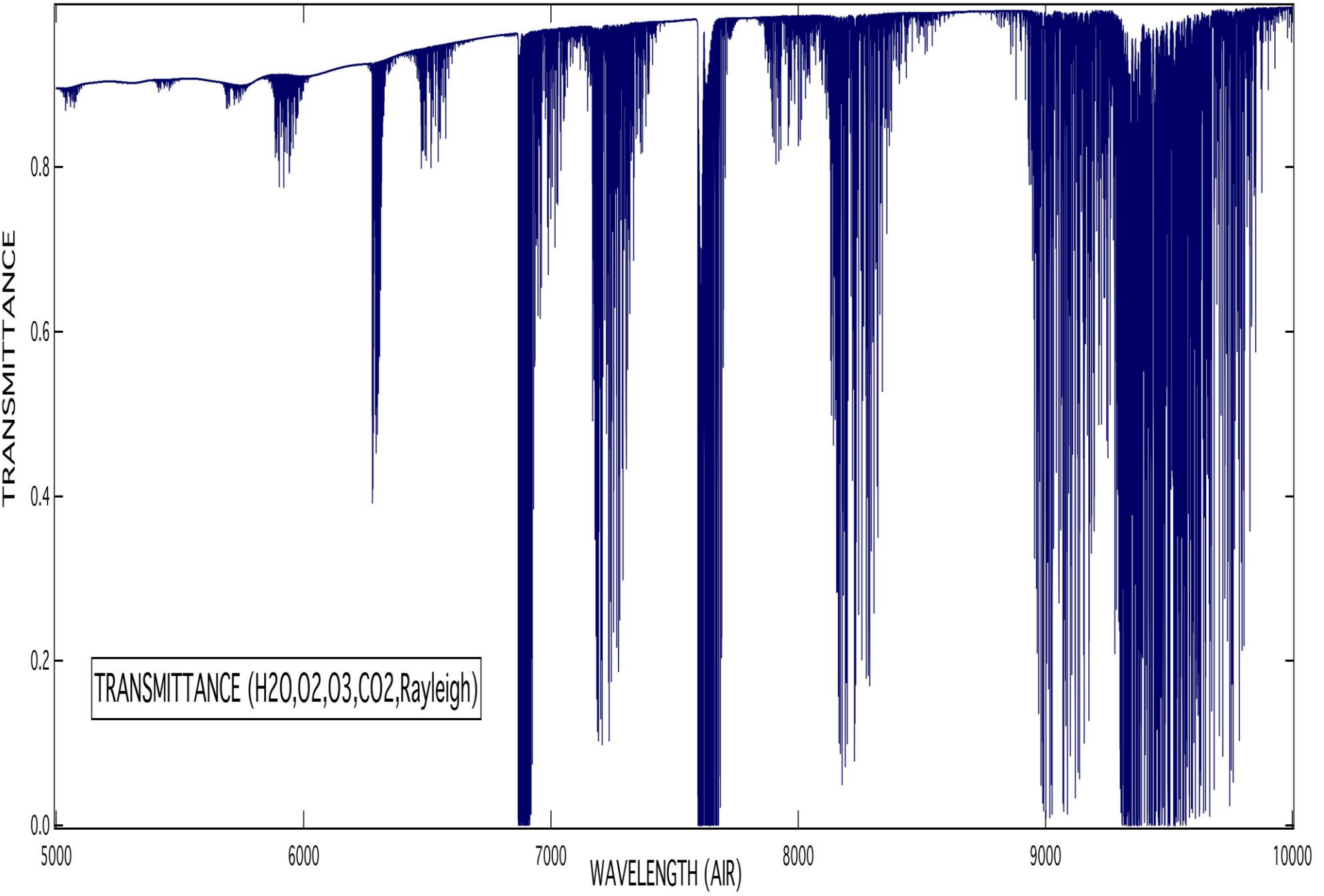
# Conclusions

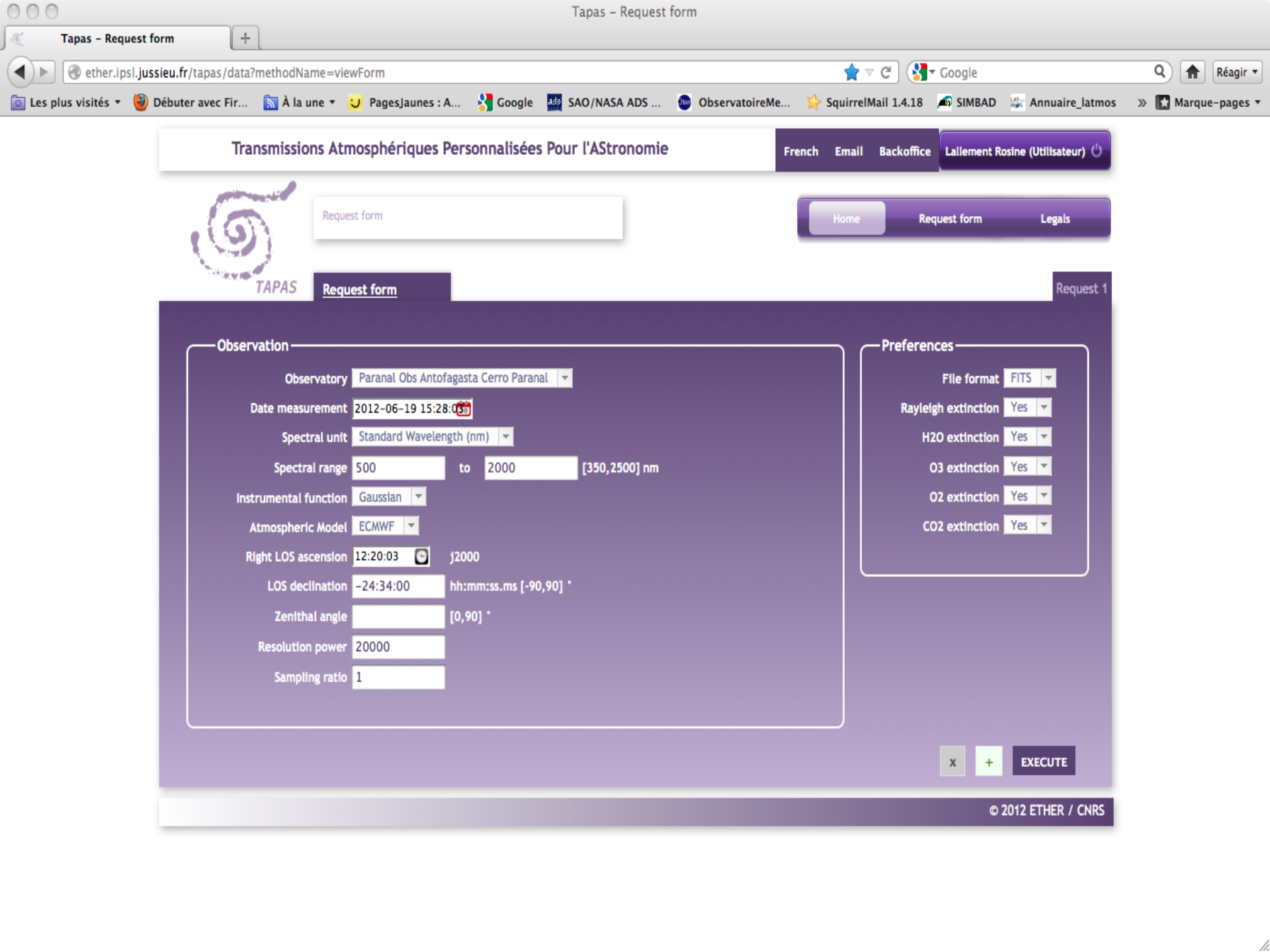
- TAPAS now open to public
- http://ether.ipsl.jussieu.fr/tapas/
- Identify telluric origin of absorption feature and molecule (otherwise, stellar or interstellar)
- Accurate wavelength calibration and ILSF retrieval of spectrometer
- Correct by division to get TOA target spectrum (need for $H_2O$ adjustment with $T^X$ method, possibly $CH_4$,$CO_2$,$N_2O$ also)
- Improve spectroscopic data base ?
- List of observatories will include soon TCCON network

TAPAS web site http://ether.ipsl.jussieu.fr/tapas/


Tr(H2Ox1.5)
star
H2O nom
H2Ox1.3
H2Ox1.5
atmospheric transmittance $H_2O$
star flux, HD135230
wavelength (nm)
1.0
0.8
0.6
0.4
0.2
0.0
1.6
1.4
1.2
1.0
695.4
695.6
695.8
696.0


H2O transmisttance
Na I D1
Na I D2
star
T1 res 44000
T2 res 40000
T3 res 50000
atmospheric transmittance $H_2O$
star flux, HD135230
wavelength (nm)
1.00
0.95
0.90
0.85
0.80
2.6
2.5
2.4
2.3
2.2
2.1
2.0
588.4
588.6
588.8
589.0
589.2
589.4
589.6
589.8


TRANSMITTANCE
0.0
0.2
0.4
0.6
0.8
TRANSMITTANCE (H2O,O2,O3,CO2,Rayleigh)
5000
6000
7000
8000
9000
10000
WAVELENGTH (AIR)


Tapas – Request form
Tapas – Request form
ether.ipsl.jussieu.fr/tapas/data?methodName=viewForm
Google
Réagir
Les plus visités
Débuter avec Fir...
À la une
PagesJaunes : A...
Google
SAO/NASA ADS ...
ObservatoireMe...
SquirrelMail 1.4.18
SIMBAD
Annuaire_latmos
Marque-pages
Transmissions Atmosphériques Personnalisées Pour l'AStronomie
French
Email
Backoffice
Lallement Rosine (Utilisateur)
TAPAS
Request form
Home
Request form
Legals
Request form
Request 1
Observation
Observatory
Paranal Obs Antofagasta Cerro Paranal
Date measurement
2012-06-19 15:28:03
Spectral unit
Standard Wavelength (nm)
Spectral range
500
to
2000
[350,2500] nm
Instrumental function
Gaussian
Atmospheric Model
ECMWF
Right LOS ascension
12:20:03
j2000
LOS declination
-24:34:00
hh:mm:ss.ms [-90,90] °
Zenithal angle
[0,90] °
Resolution power
20000
Sampling ratio
1
Preferences
File format
FITS
Rayleigh extinction
Yes
H2O extinction
Yes
O3 extinction
Yes
O2 extinction
Yes
CO2 extinction
Yes
x
+
EXECUTE
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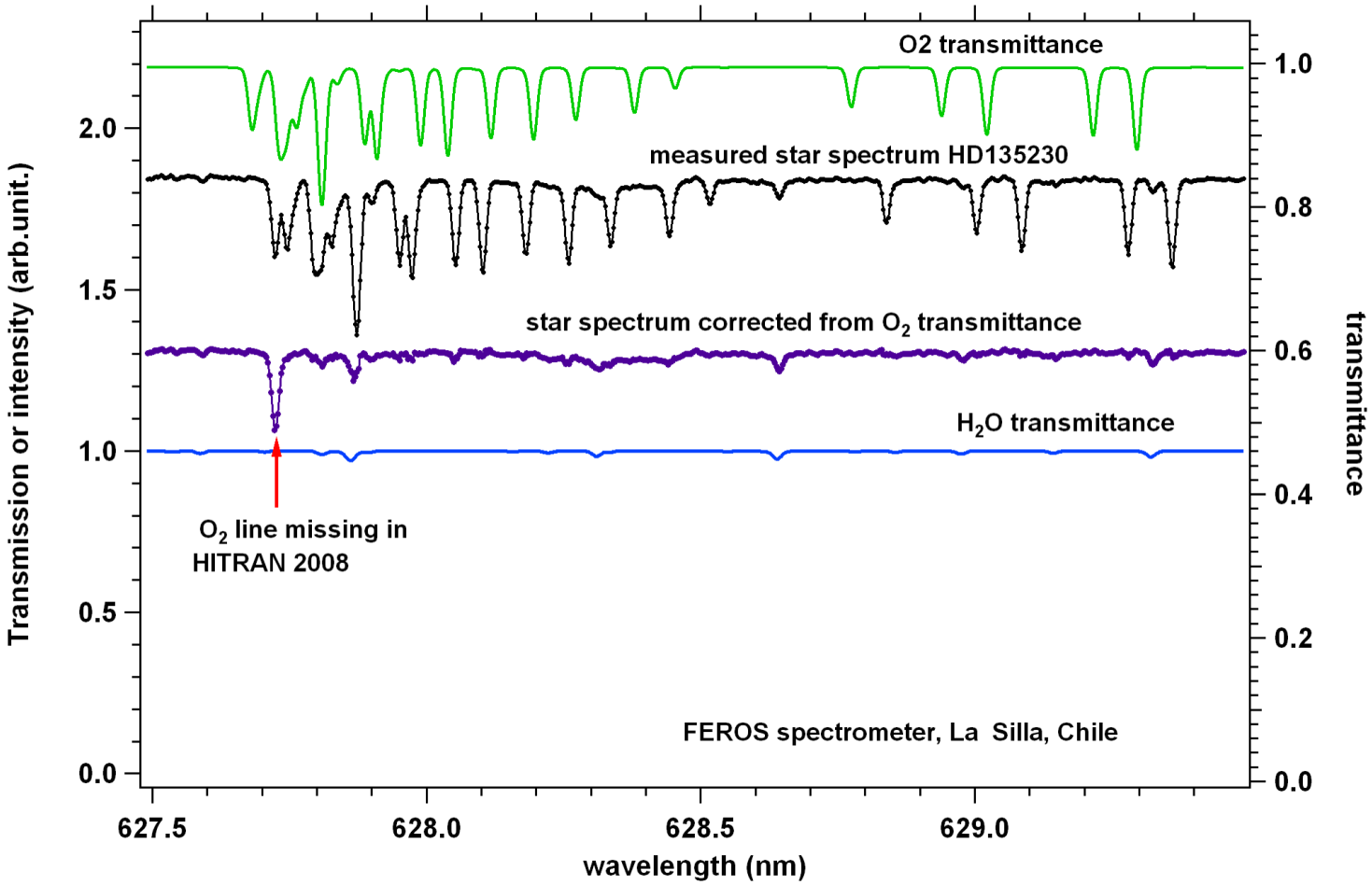
# TAPAS Abstract


- All astronomical targets (stars, galaxies, planets, exo-planets…) are seen from ground-based observatories through the Earth's atmosphere, which is polluting their spectra. In the field of stellar high resolution spectroscopy, there is a growing need for an accurate correction of atmospheric transmission, to reach interesting but contaminated spectral regions.
- The authors and their institutes are developing a web-based service, TAPAS
- («  Transmissions Atmosphériques Personnalisée pour l'Astronomie ». The user files a request indicating the time, ground location, and Zenith Angle of the star observation. The actual atmospheric profile (temperature, pressure, humidity, ozone content) at that time and place is retrieved from the ETHER atmospheric data base, and the atmospheric transmission is computed from LBLRTM software and HITRAN data base.
- It may be remarked that the user may also contribute to general knowledge of the atmospheric transmission, if he/she finds systematic discrepancies between synthetic transmissions and the observed spectra. This has already happened in the past.
- We acknowledge the support of CNES and CNRS.


O2 transmittance
measured star spectrum HD135230
star spectrum corrected from $O_2$ transmittance
$H_2O$ transmittance
$O_2$ line missing in
HITRAN 2008
FEROS spectrometer, La Silla, Chile
Transmission or intensity (arb.unit.)
transmittance
wavelength (nm)
0.0
0.5
1.0
1.5
2.0
0.0
0.2
0.4
0.6
0.8
1.0
627.5
628.0
628.5
629.0