E-ELT HIRES astrobiological science case for Solar System:

The case of C/2014 Q2 Lovejoy.

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Summary:

1- HIRES @EELT and GIANO @TNG

2- Water: the puzzling origin of oceans on Earth

3- Comet C/2014 Q2 Lovjoy observations

4- Data reduction

5- Analysis with Cometary Fluorescence Emission Model

6- Conclusions and future perspectives
1- HIRES @EELT and GIANO @TNG

**EELT-ESO**

- Detector: HAWAII-2 2048x2048
- Pixel size: 18 microns
- Gain: 2.2 e-/ADU
- Readout Noise: 5 e-
- Dark Current: 0.05 e-/s/pixel
- Wavelength Coverage: 0.95 - 2.45 um
- Spectral resolution: 50000
- Fiber Size: 85 microns - 1.0 arcsec
- Slicer: 2x

**GIANO**

- Detector: HAWAII-2 2048x2048
- Pixel size: 18 microns
- Gain: 2.2 e-/ADU
- Readout Noise: 5 e-
- Wavelength Coverage: 0.35 - 2.45 um
- Spectral resolution: 100000
- Fiber Size: 85 microns - 1.0 arcsec
- Slicer: 2x
1- HIRES @EELT and GIANO @TNG

GIANO Echellogram

Ord. 76
\( \lambda_c = 1.01 \mu m \)

Ord. 61
\( \lambda_c = 1.26 \mu m \)

Ord. 46
\( \lambda_c = 1.66 \mu m \)

Ord. 34
\( \lambda_c = 2.25 \mu m \)
2- Water: the puzzling origin of ocean on Earth

Within frost line, rocks and metals condense, hydrogen compounds stay gaseous.

Beyond frost line, hydrogen compounds, rocks, and metals condense.

2.7 AU

30 AU

Who delivered water on Earth?
2- Water: the puzzling origin of ocean on Earth

Are organics and water delivered on Earth by comets?
2- Water: the puzzling origin of ocean on Earth

Is the present D/H on Earth the primordial one?
Does different class of comets have the same D/H?
Could other mechanisms be possible?

[Mumma & Charnley, 2011]
3- C/2014 Q2 comet Lovejoy observations

R_H = 1.29 AU
\( \Delta = 0.80 \text{ AU} \)
\( V_{geo} = 33.4 \text{ km/s} \)

Extended Source (comet):

Nodding:

Sky:

Point Source:

Sky:
3- C/2014 Q2 comet Lovejoy observations

Star:

Comet with nucleus on A fiber:

- coma
- nucleus
3- C/2014 Q2 comet Lovejoy observations

Order # 40

![Graph showing comet C/2014 Q2 Lovejoy observations. The graph plots flux (ADU) against wavelength (nm) with four lines representing different observations: comet C/2014 Q2 Lovejoy, Star Hip 029216, and Sky.](attachment:image.png)
4- Data reduction

GIANO Order # 40

Calibration of spectra with Transmittance Terrestrial Atmosphere Model. [Villanueva et al. 2015]

Cometary spectra residual for nucleus and coma

[Faggi et al. 2015 (in prep.)]
Fluorescence = Pumping + Emission

Pumping ≈ $F_{\text{sun}} \times B_{12}$

Emission ≈ Pumping * BR

[Image of energy level diagram and emission rates for Water ($H_2O$) fluorescence.]

[Text: Villanueva et. al. 2012]
5- Analysis with Cometary Fluorescence Emission Model

GIANO Order #40
Molecular water (H$_2$O) emission

Continuum

Water fluorescence at 80K

 Flux density [1E-20 W m$^{-2}$ cm$^{-2}$]

 Frequency [cm$^{-1}$]

[Faggi et al. 2015 (in prep) ]
6-Conclusions and future perspectives

- We obtain promising results on $\text{H}_2\text{O}$ in comet Lovejoy for order #40 of GIANO echellogramm: $Q(\text{H}_2\text{O}) = 3.3 \times 10^{29}$ mol s$^{-1}$. [Faggi et al. 2015, in prep.]

- We are going to measure HDO and OH $\rightarrow$ D/H and OPR

- We observed CN, C$_2$ $\rightarrow$ new model development

- Search for other emissions across GIANO echellogram (NH$_3$, CH$_4$, CO..)

- Submitted proposal for C/2014 US10 (Catalina) with GIANO @TNG.
6-Conclusions and future perspectives

With HIRES @EELT we would get a “quantum leap” in the results!!

- EELT collective area 100 times greater than TNG
- HIRES resolving power twice than GIANO
- Extension in the visible region (NH$_2$, CN, C$_2$, C$_3$, O[I]...)

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- measure D/H for JFC
- enhancement of statistic of D/H in comets
- isotopic ratio other species (C, N..)
- OPR ratio