Current/Future UV Capabilities

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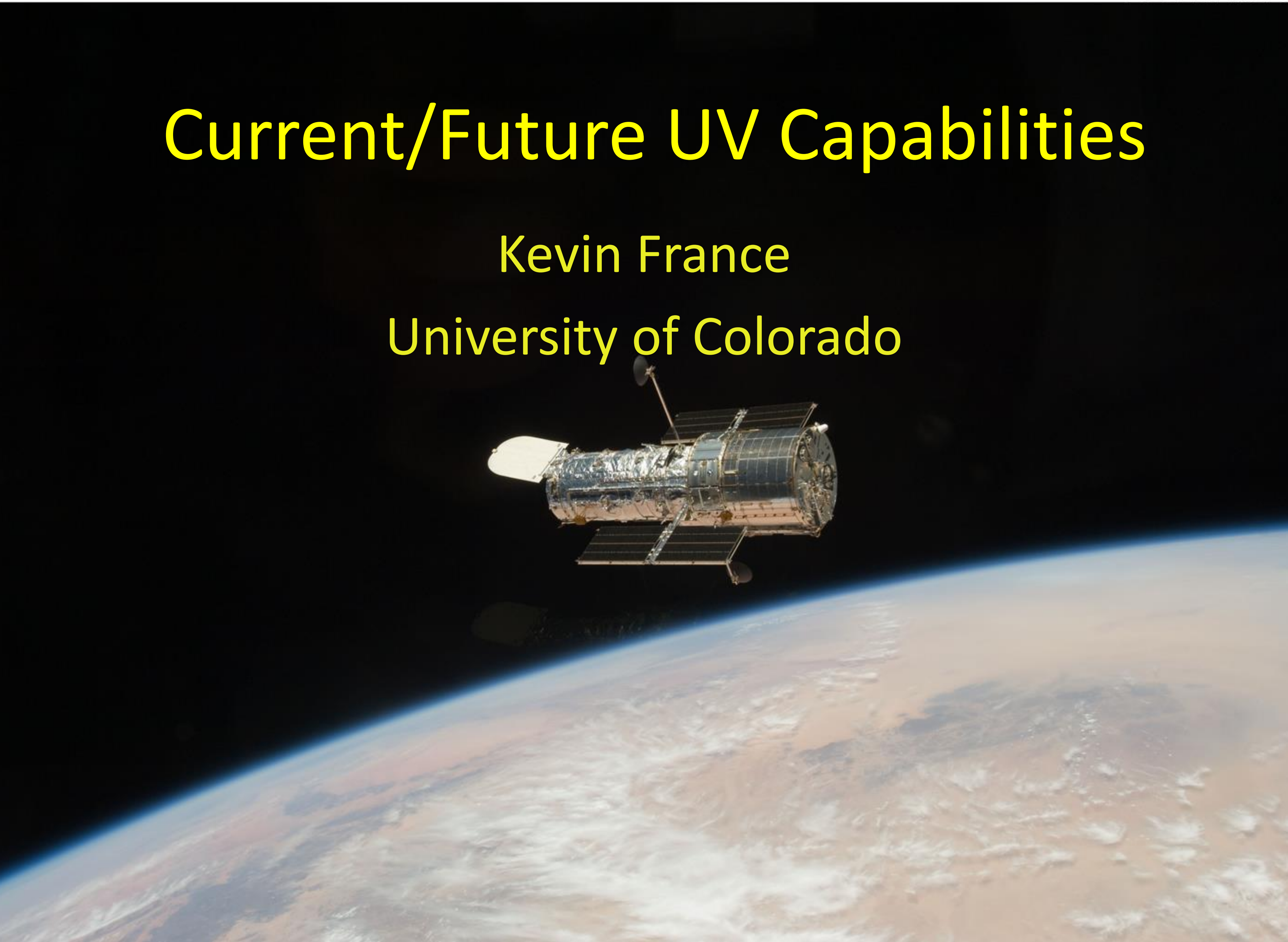


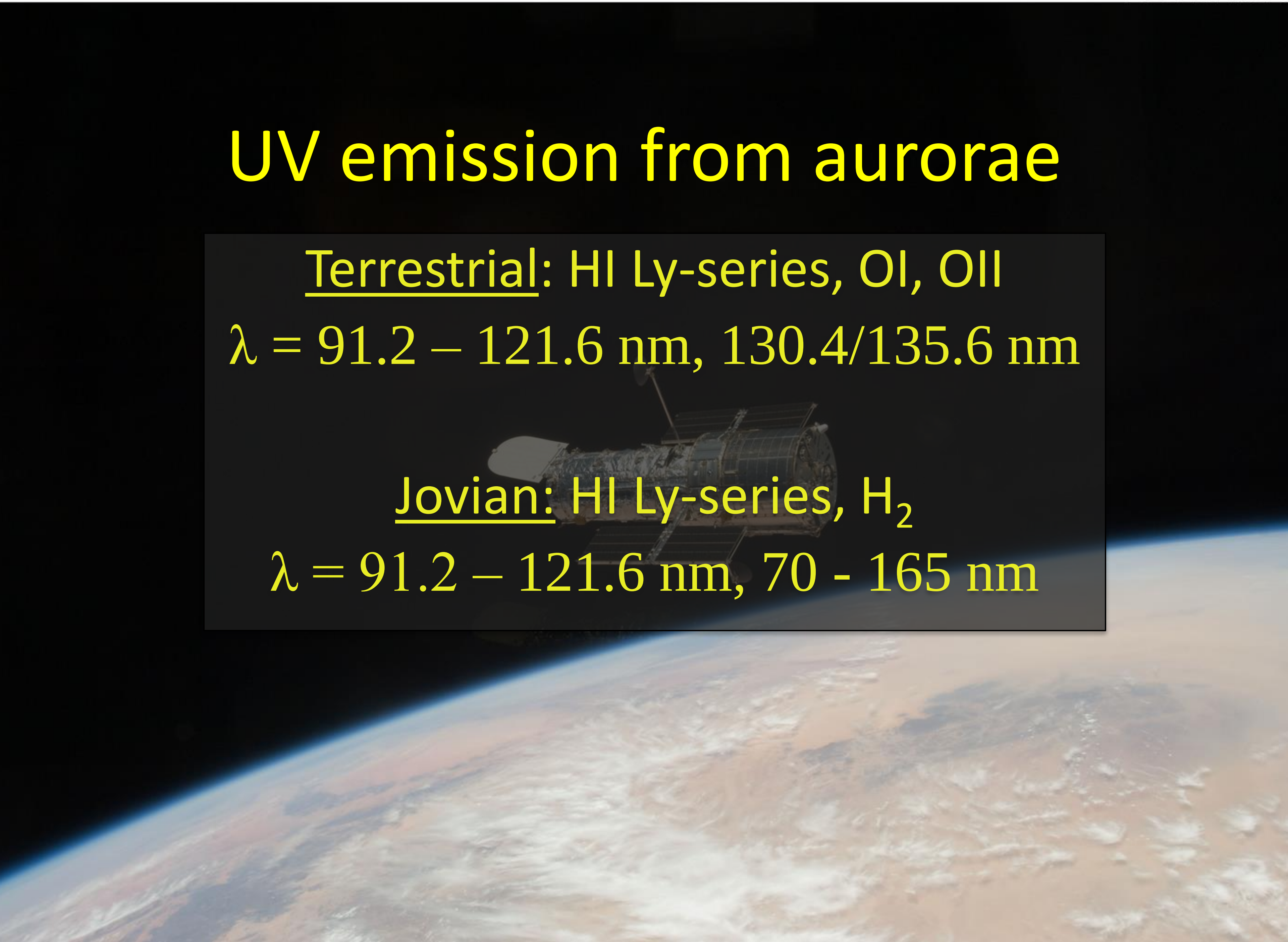
UV emission from aurorae

Terrestrial: HI Ly-series, OI, OII

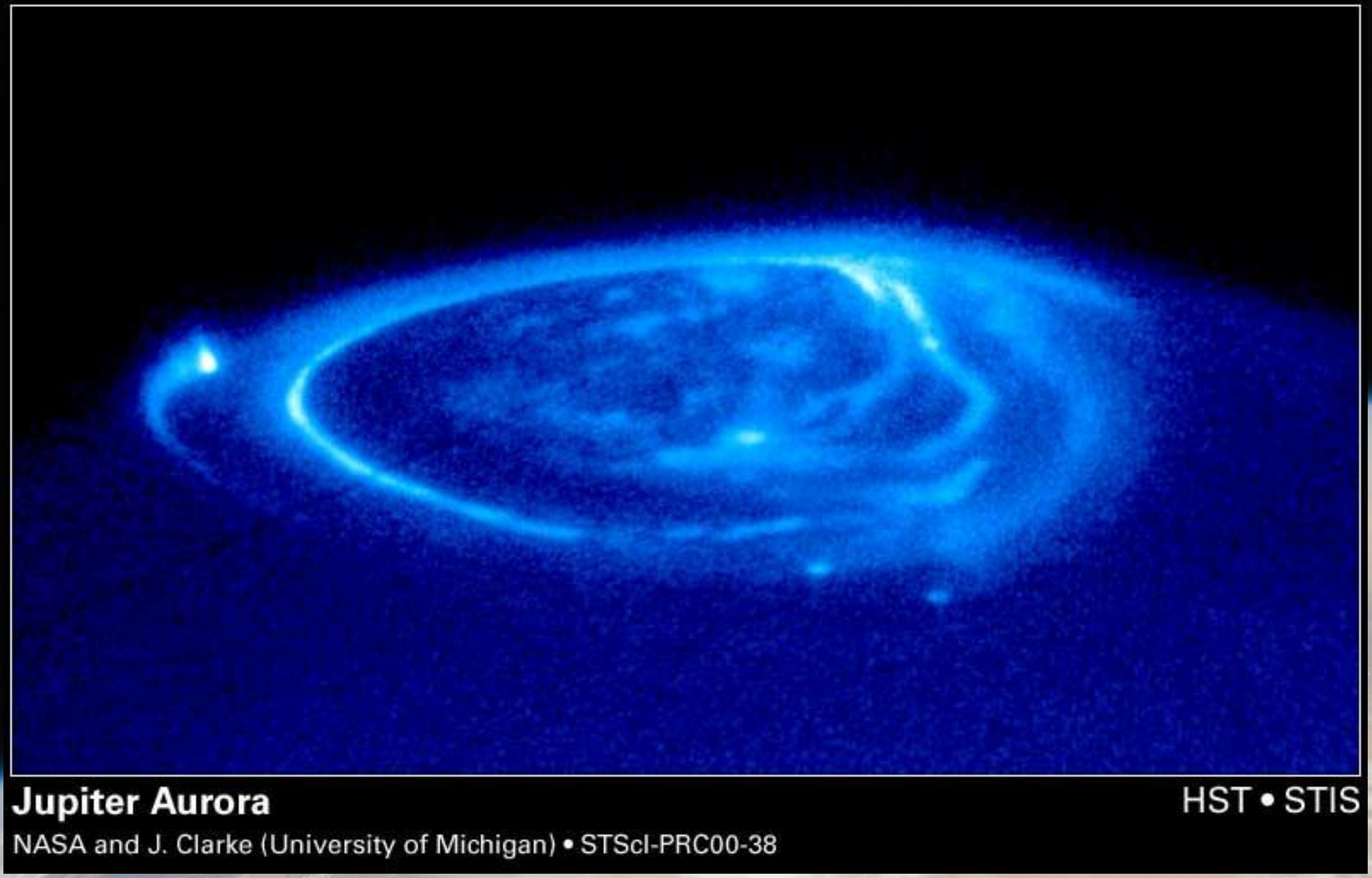
$\lambda = 91.2 - 121.6$ nm, 130.4/135.6 nm

Jovian: HI Ly-series, H_2

$\lambda = 91.2 - 121.6$ nm, 70 - 165 nm



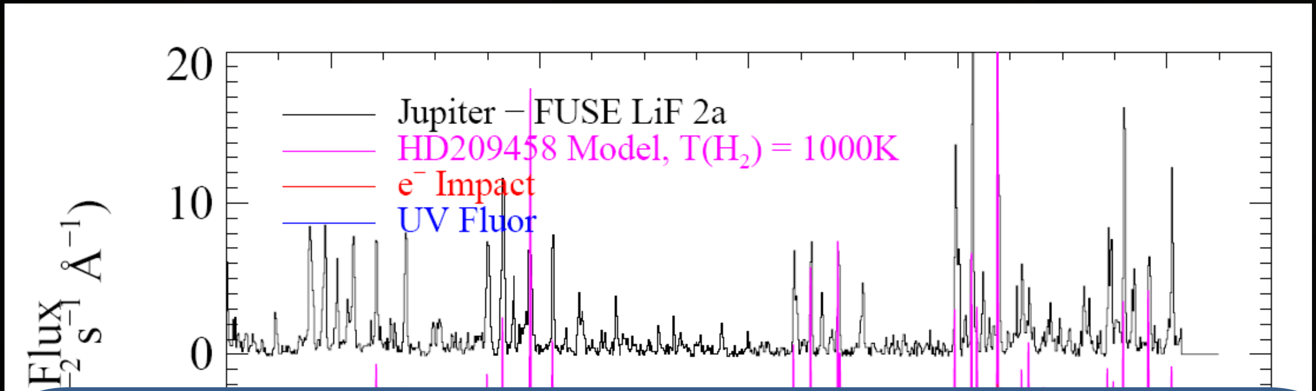
UV emission from aurorae



S125E011835

Gustin et al. (2004)
Icarus, 171, 336

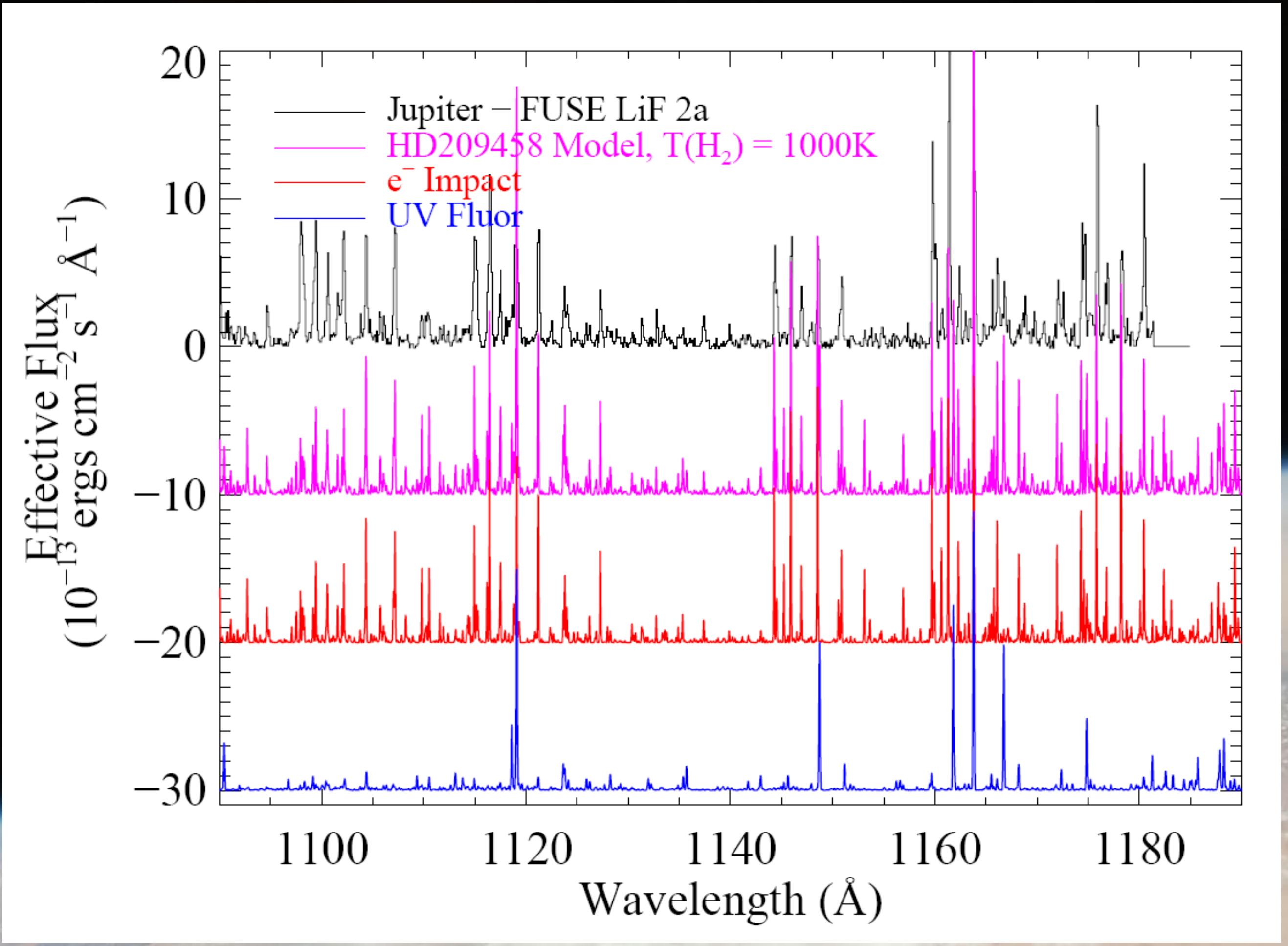
UV emission from aurorae



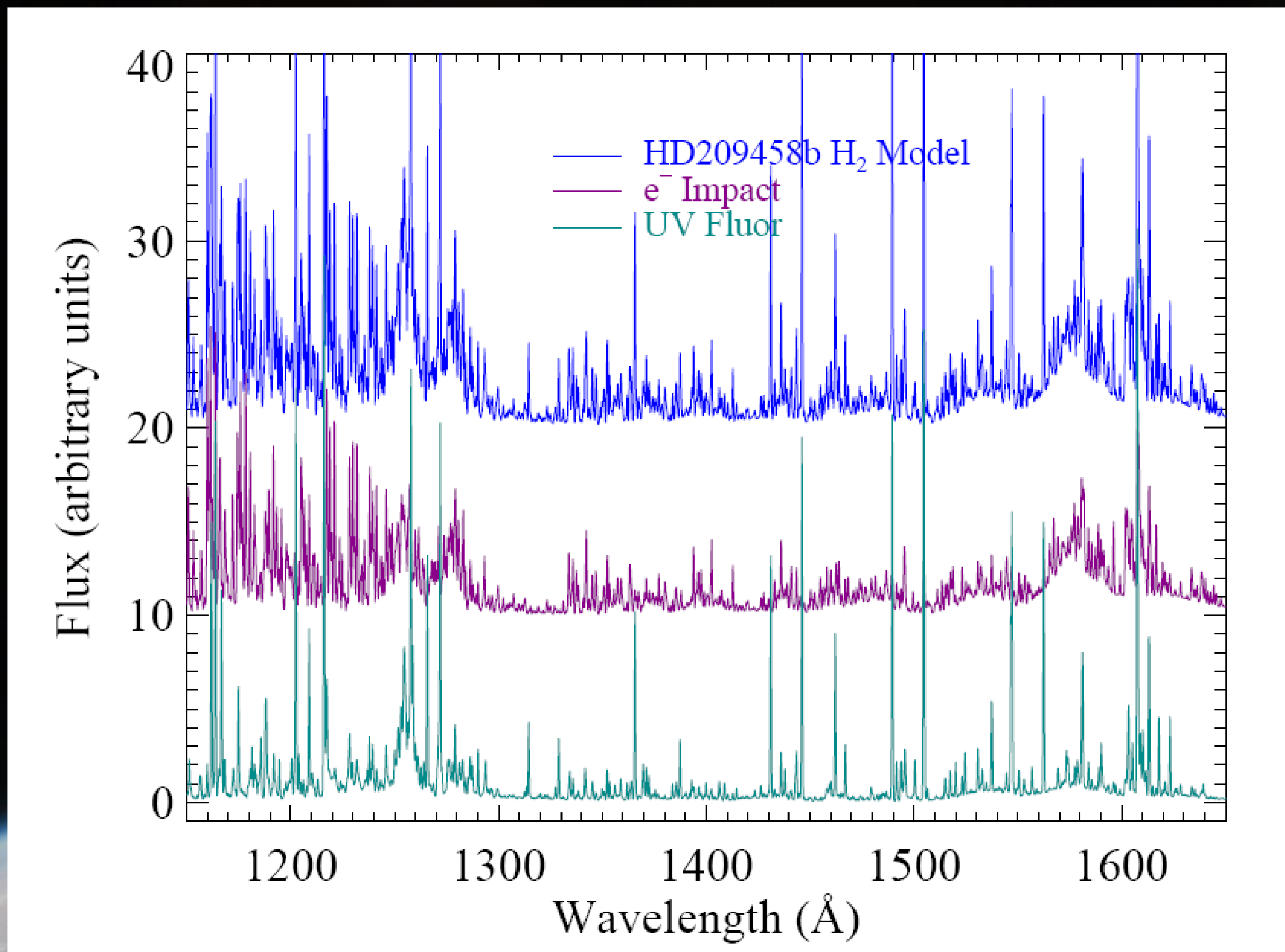
Diagnostic power of auroral H_2 emission:

1) column density and kinetic (rotational) temperature of atmospheric emission layer
2) temperature structure of overlying layers (similar to those derived from H_3^+ spectra)
3) precipitating electron energy distribution
4) hydrocarbon (mostly methane) column density above the emitting layer

UV emission from aurorae

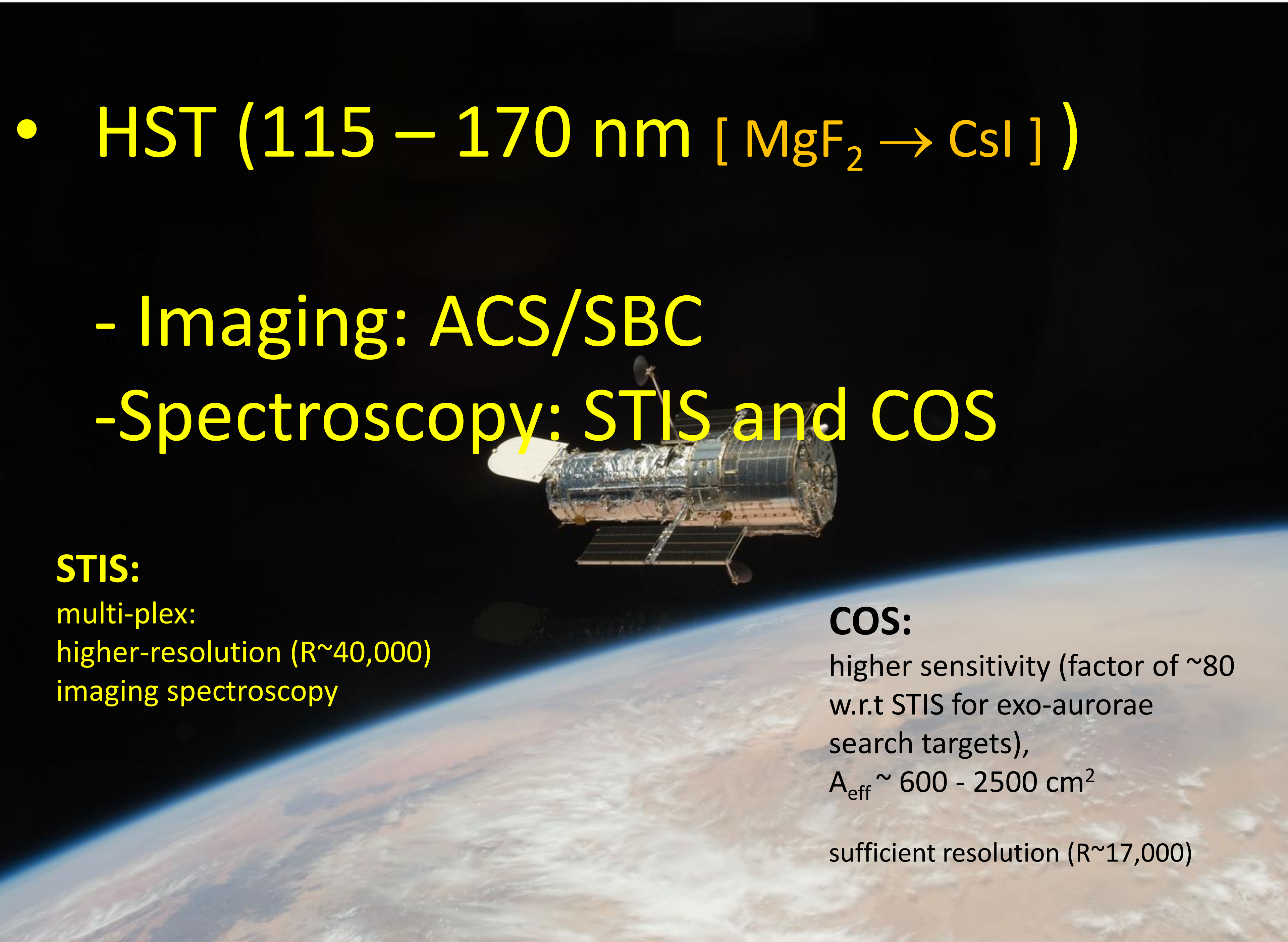


UV emission from aurorae/dayglow



- HST (115 – 170 nm [$MgF_2 \rightarrow CsI$])

  - Imaging: ACS/SBC
  - Spectroscopy: STIS and COS



STIS:
multi-plex:
higher-resolution (R~40,000)
imaging spectroscopy

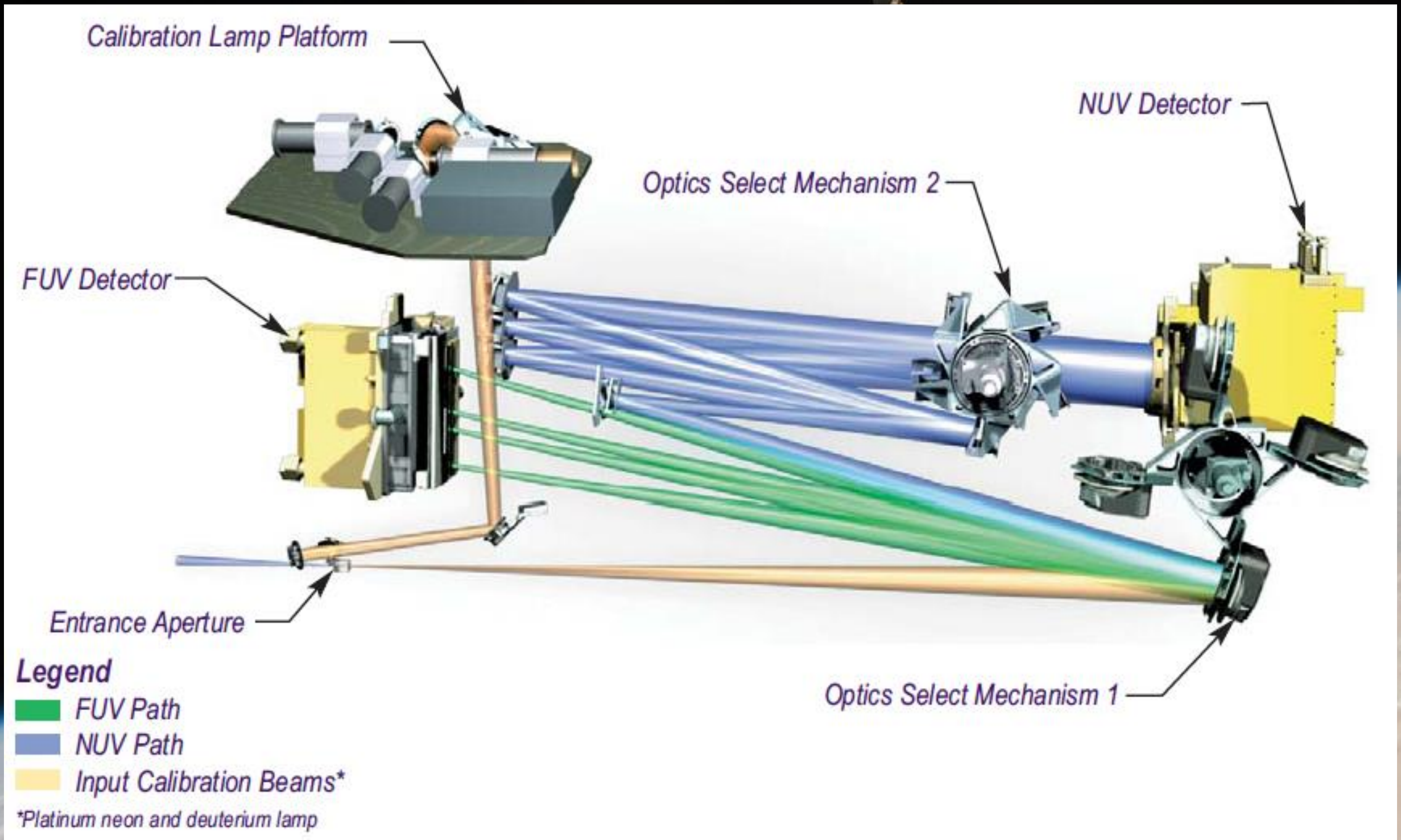
COS:
higher sensitivity (factor of ~80 w.r.t STIS for exo-aurorae search targets),
A_{eff} ~ 600 - 2500 cm^2

sufficient resolution (R~17,000)

Cosmic Origins Spectrograph

Cosmic Origins Spectrograph

- $900 \leq \lambda \leq 3200$ Å
- Holographically ruled diffraction grating for simultaneous dispersion, focus, and correction of spherical aberration of *HST* primary



Cosmic Origins Spectrograph

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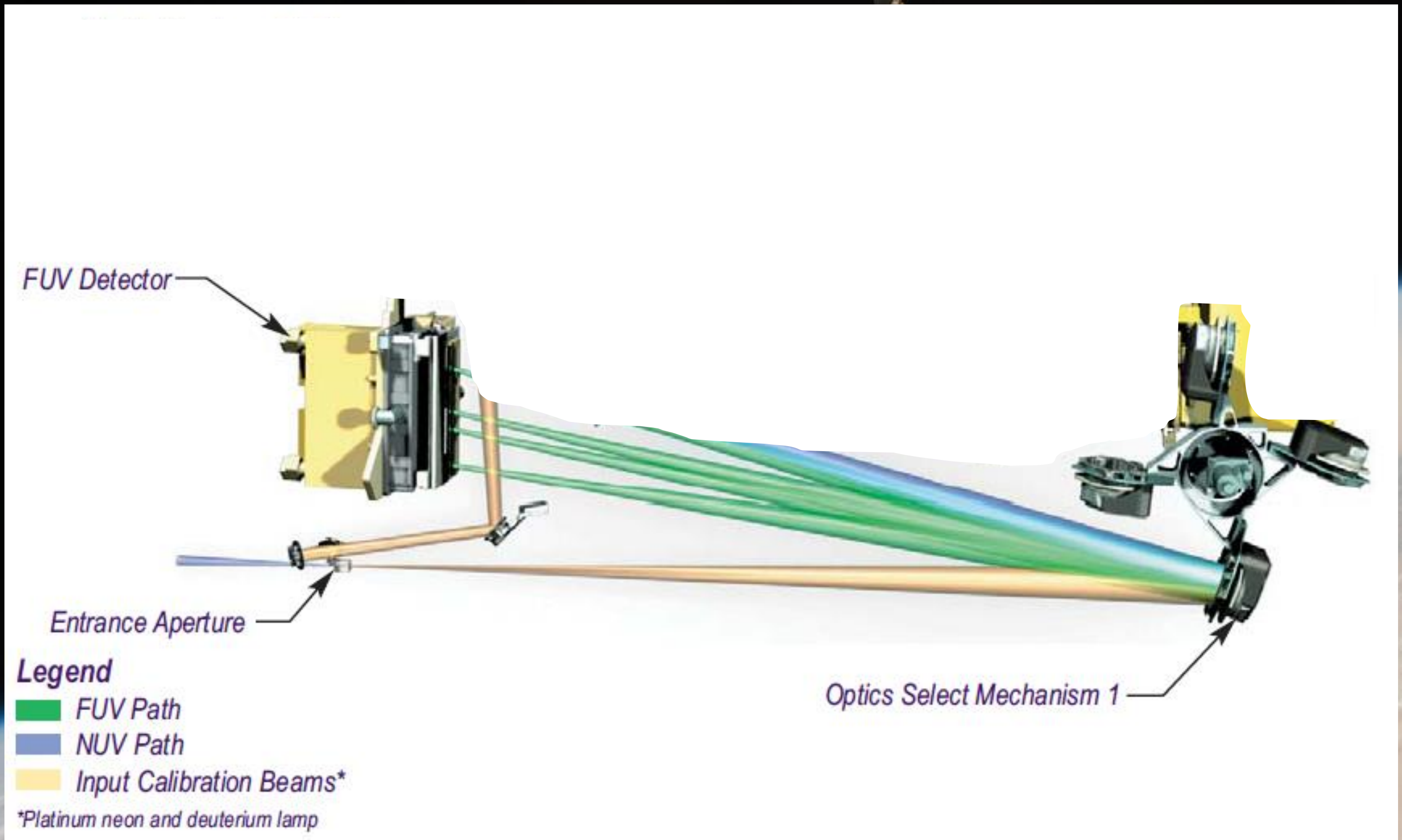
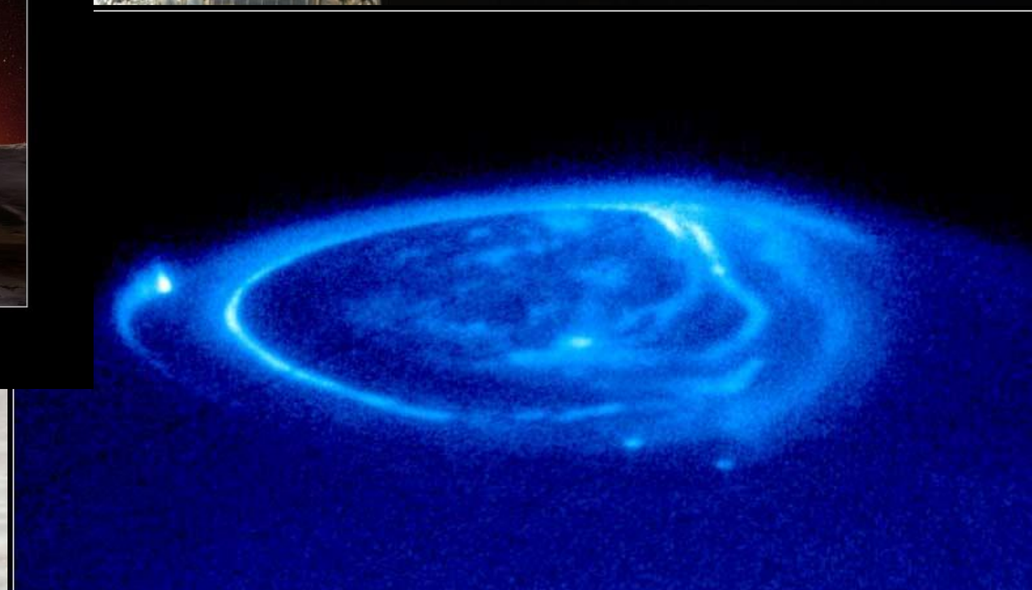


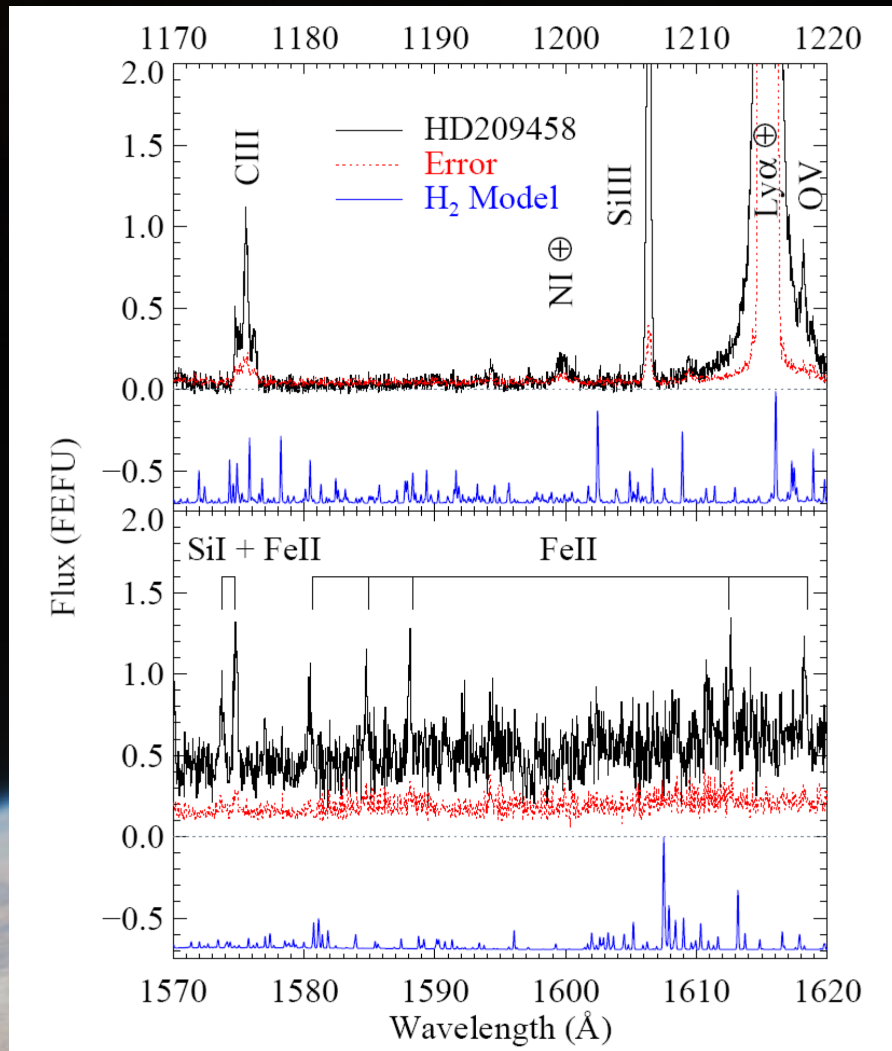
UV emission from HD209458b

Artist's View of Extrasolar Planet HD 209458b
NASA, ESA, and G. Bacon (STScI) ▪ STScI-PRC10-21



Jupiter Aurora HST • STIS
NASA and J. Clarke (University of Michigan) • STScI-PRC00-38

UV upper limits from HD209458b

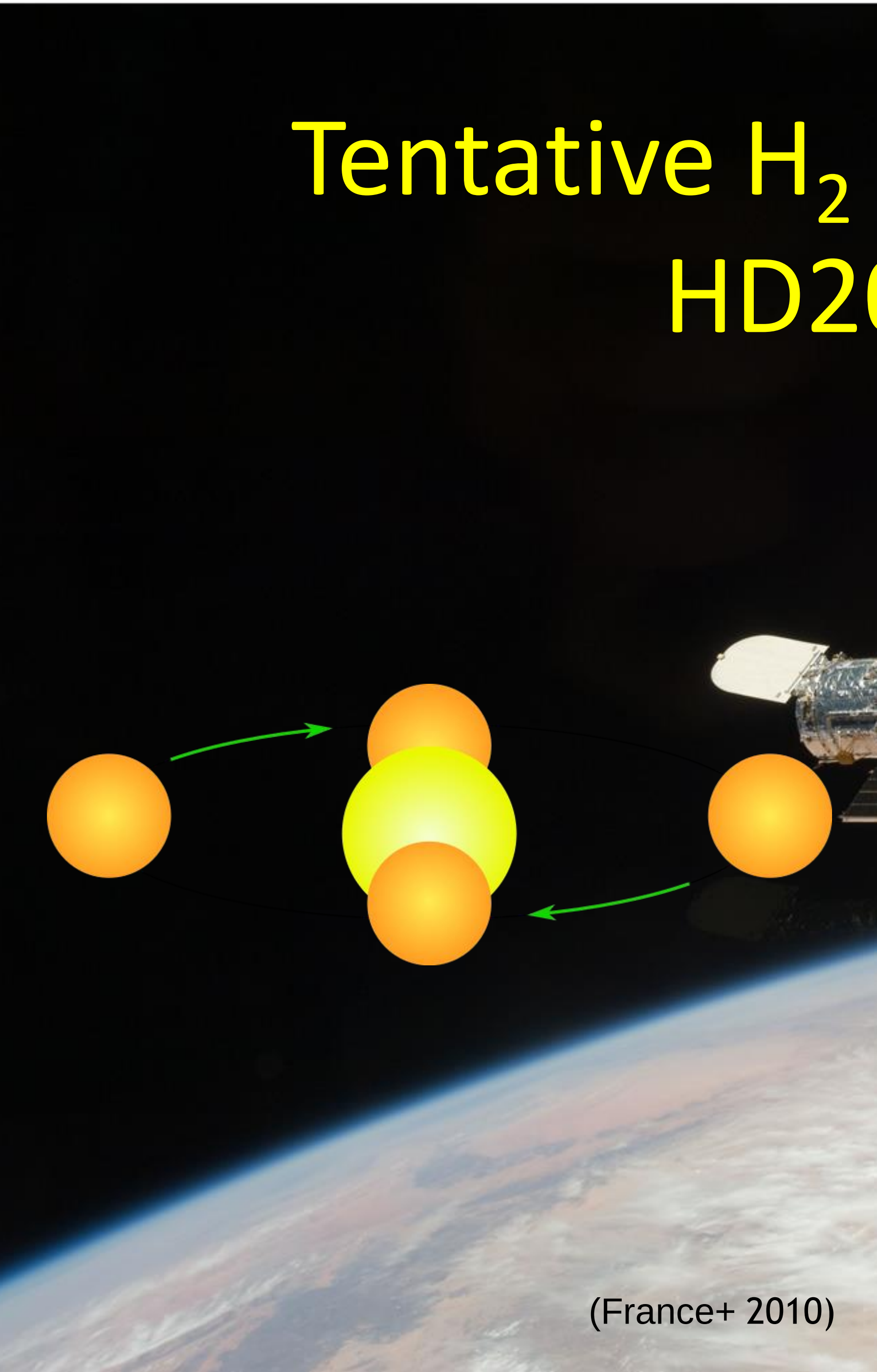


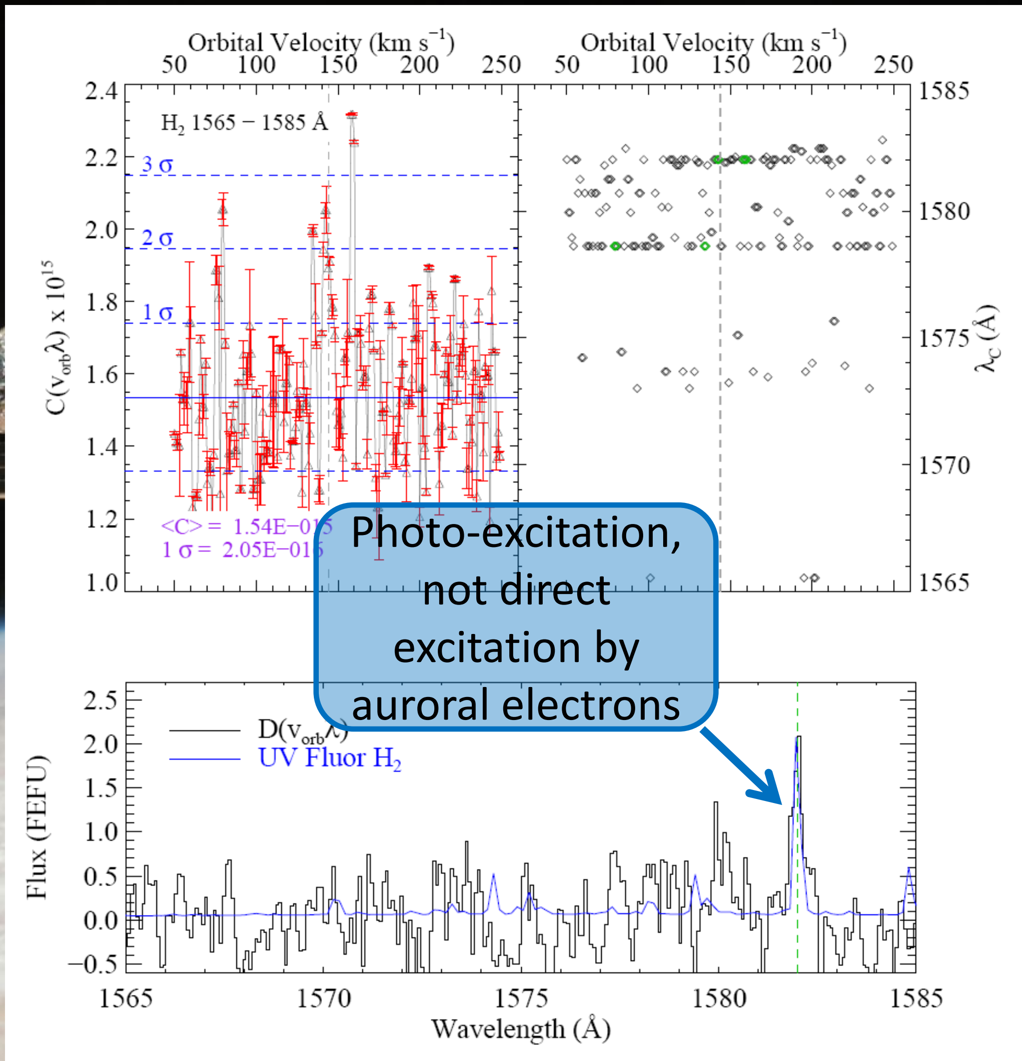
UV upper limits from HD209458b

Table 4. Limits on H_2 emission from the atmosphere of HD209458b.

Line ID[b]	λ_{rest} (Å)	Excitation	Brightness[a] (10^{-17} ergs cm^{-2} s^{-1})	Notes[c]
$C - X$ (1 – 4) P(5)	1171.96	e^- Impact	≤ 0.76	···
$C - X$ (2 – 5) Q(1)	1175.83	e^- Impact	≤ 6.22	Blend with C III
$C - X$ (4 – 8) Q(1)	1239.53	e^- Impact	≤ 0.44	···
$B - X$ (1 – 3) R(5)	1265.67	UV photon, Lyα	≤ 0.71	···
$C - X$ (7 – 12) Q(3)	1279.10	e^- Impact	≤ 0.80	···
$B - X$ (6 – 7) P(1)	1365.66	UV photon, Lyβ	≤ 2.01	···
$B - X$ (6 – 9) P(1)	1461.97	UV photon, Lyβ	≤ 3.36	Stellar continuum at $\lambda \gtrsim 1420$ Å
$B - X$ (1 – 8) R(3)	1547.34	UV photon, Lyα	≤ 5.83	···
$B - X$ (7 – 13) P(3)	1580.74	e^- Impact	≤ 10.14	Blend with Fe II
$B - X$ (2 – 9) P(4)	1581.11	UV photon	11.72 ± 3.08	Blend with Fe II
$B - X$ (6 – 12) P(1)	1581.11	UV photon, Lyβ	···	Blend with Fe II
$B - X$ (6 – 13) P(1)	1607.50	UV photon, Lyβ	≤ 10.54	···
$B - X$ (5 – 12) P(3)	1613.18	e^- Impact + UV Photon, O VI	≤ 12.80	···

Tentative H_2 Detection from HD209458b

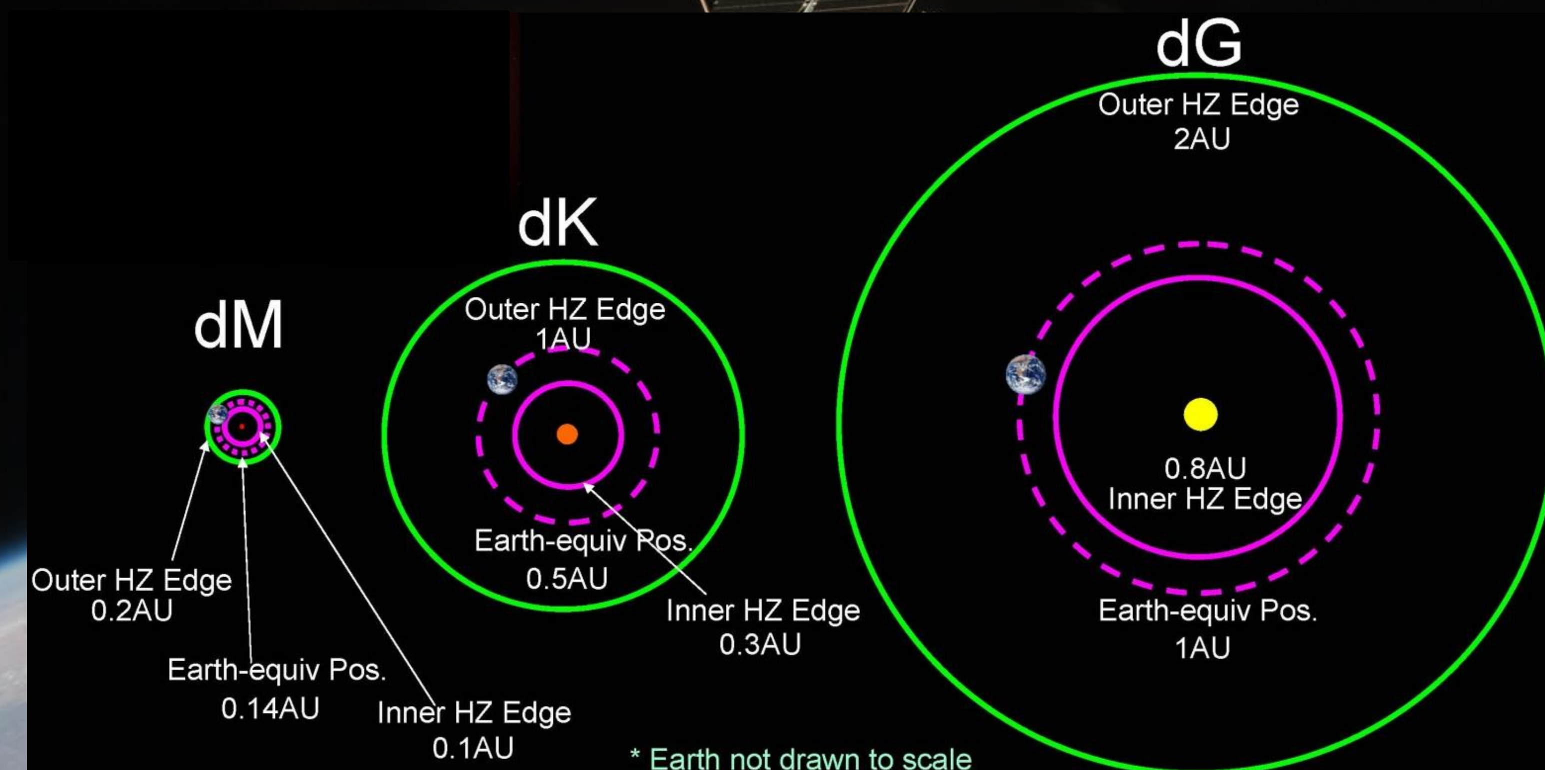




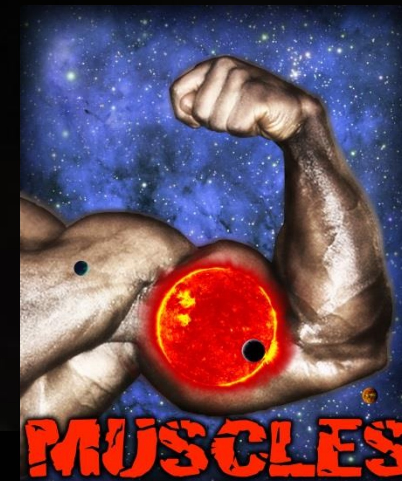
(France+ 2010)

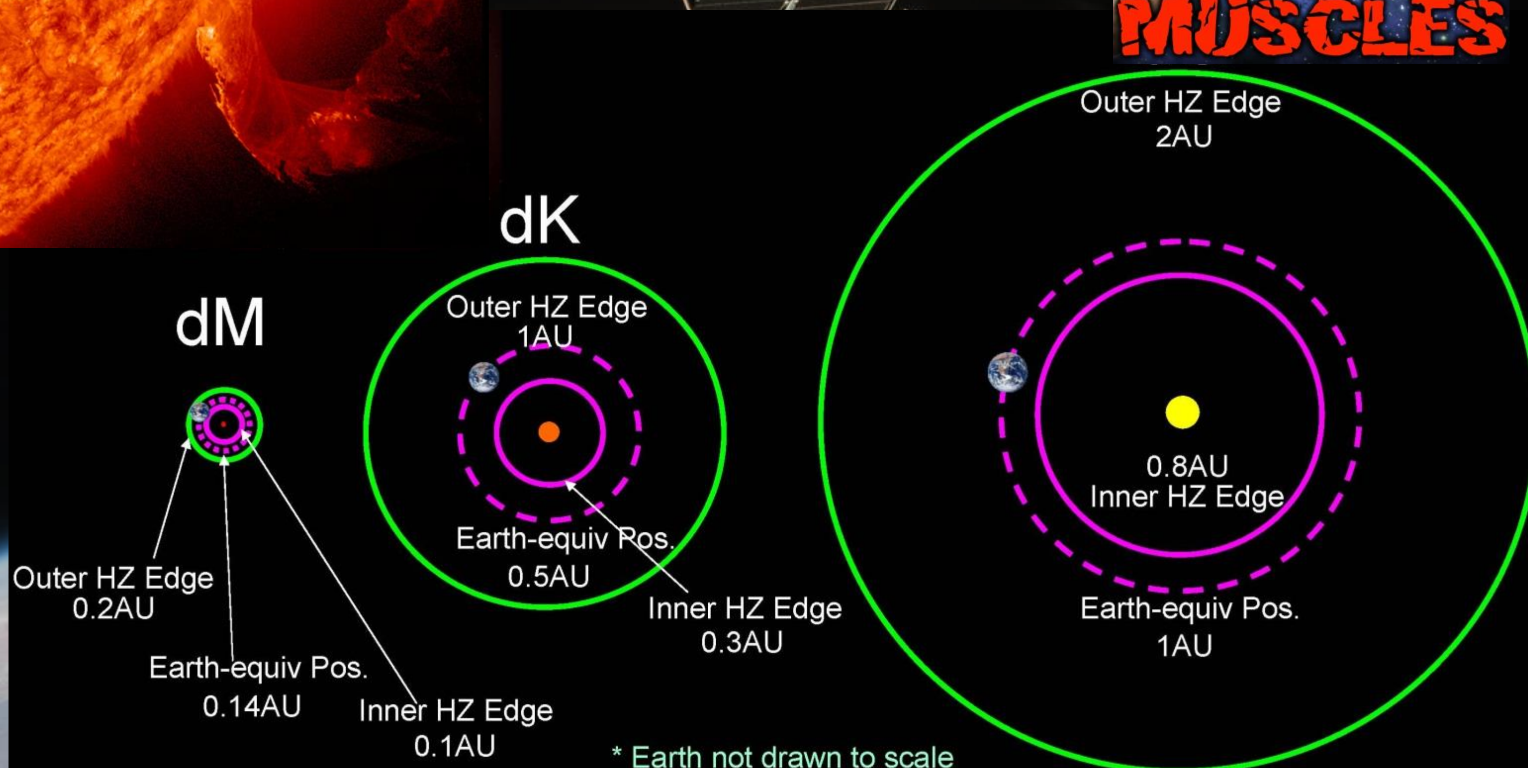
UV emission from M dwarf exoplanet systems

UV emission from M dwarf exoplanet systems

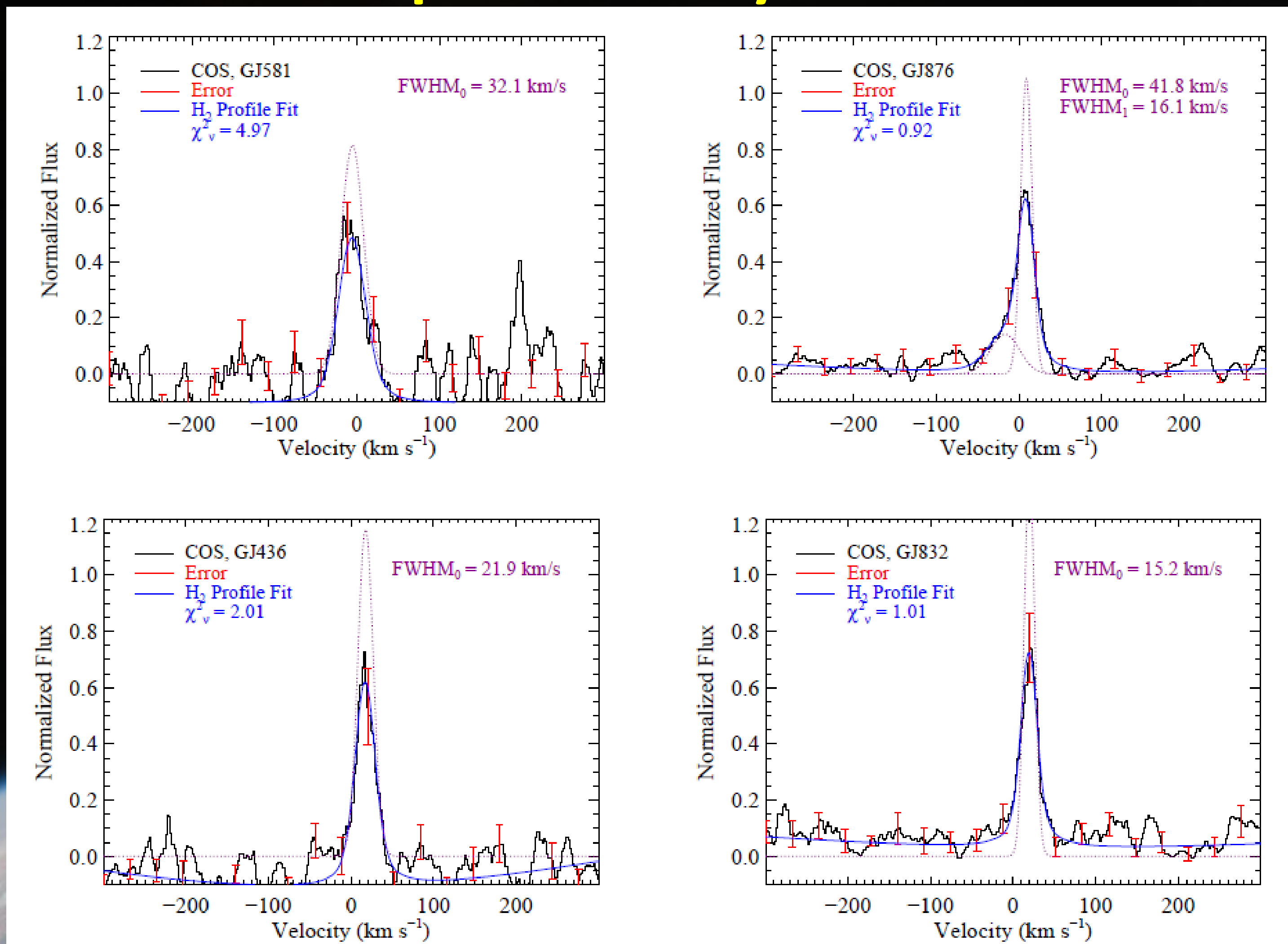


UV emission from M dwarf exoplanet systems

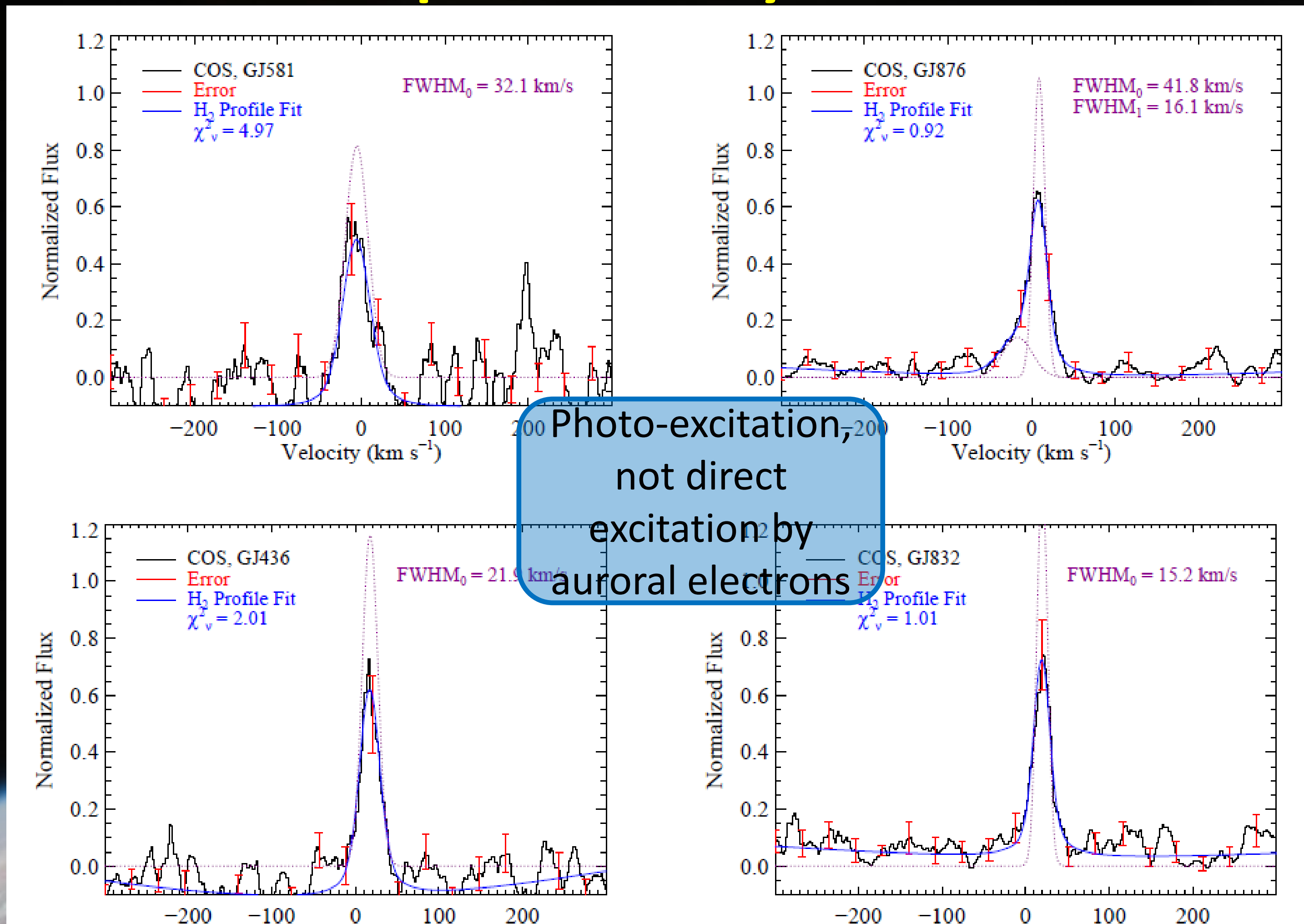




UV emission from M dwarf exoplanet systems

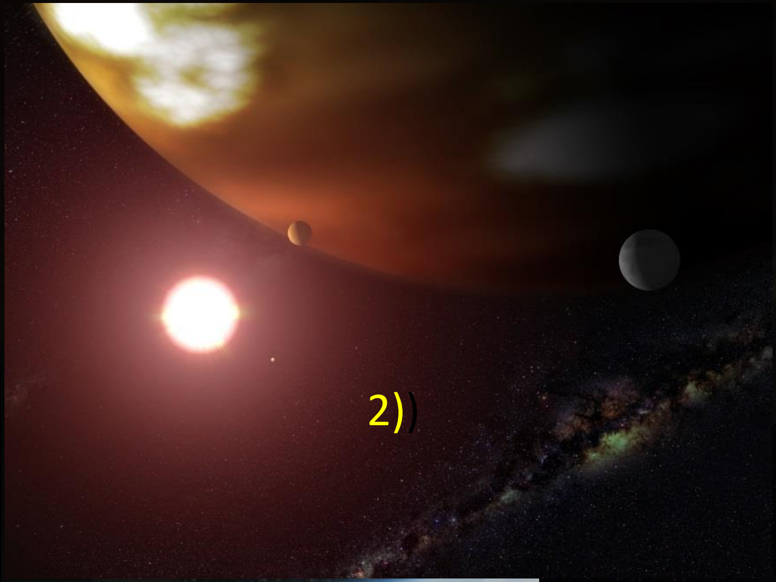


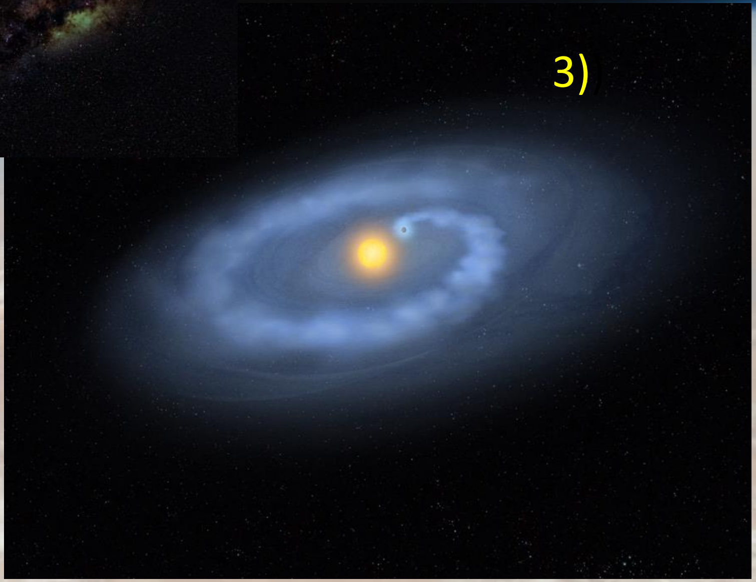
UV emission from M dwarf exoplanet systems



(France+ 2013)

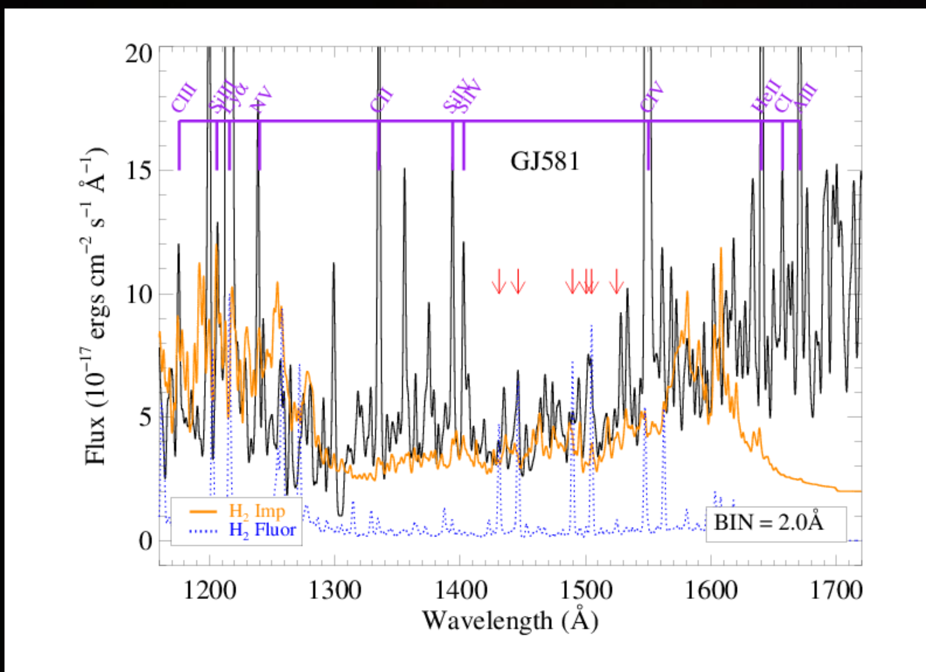
UV emission from M dwarf exoplanet systems





(France+ 2013)

Exoplanetary systems with potential auroral emission limits



Jupiters:

HD 209458, HD 189733, GJ 876, GJ 832, ε Eri, 2M1207

Neptunes:

GJ 436, GJ 581

Super-Earths:

GJ 581, GJ 667C, GJ 1214, GJ 876, 55 Cnc

(France+ TBD)

Future UV prospects

Nothing in the queue after HST

Next UV/vis flagship (4-8m) ~ 2035?

SMEX/MIDEX, possible start in this decade, launch in 2018 – 2022 timeframe

Future UV prospects

<u>SMEX AO – sequestration – Fall 2014?</u>

1m mirror + improved components

Exoplanet auroral studies: compatible with other primary mission science (e.g, IGM/CGM emission mapping, protoplanetary gas disk characterization, HZ radiation fields)

Technology development paths

Technology development paths to get to HST-like capability with Explorer-class aperture:

- UV/vis coatings (France/Nikzad APRA, Quijada SAT)

- UV detectors:

Microchannel plate arrays (Vallerga SAT)

δ-doped CCDs (Nikzad SAT)

HEROIC CMOS readouts (France APRA & Roman)

low-Z MCPs & ALD coatings (Siegmund APRA)

Technology development paths to get to HST-like capability with Explorer-class aperture:

- <u>Flight Demonstration → TRL 6/7</u>

Sounding Rockets (McCandliss - JHU, France - CU, Chakrabarti & Cook – UMLowell; APRA)

Balloons (Martin – Caltech; APRA)

CubeSats?