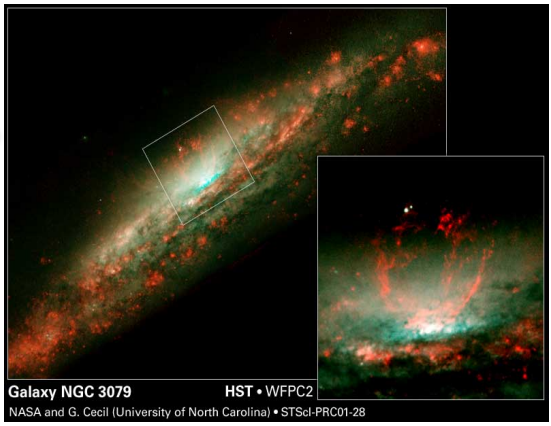
LUVOIR-POLLUX: Massive stars
Science objectives & instrument requirements

WG (so far): Evans, Bouret, Baade, Garcia, Nazé, Neiner, Sana

Paris – Apr 2017

Science & Technology Facilities Council
UK Astronomy Technology Centre

- $M > 8\ M_{\odot}$ → **Nucleosynthesis beyond O** → **Evolution** → **ISM/IGM**



- $L > 10^5\ L_{\odot}$ → **UV radiation** → **Ionisation of HII regions**

- $T_{eff} > 20000$ K → **Recent stellar formation in galaxies**

Science case & requirements

Activity in Jan/Feb: scientific topics for whole LUVOIR mission

- How do properties and evolution of massive stars vary with metallicity?
  - Physical parameters as a function of Z
  - Characterising the late stages of evolution (WR, LBV, RSG) in Local Group galaxies
  - Do we see evidence for chemically-homogeneous evolution?

- Physics of radiatively-driven winds
  - What are mass-loss rates and terminal velocities?
  - What is the effect of rotation on wind parameters?
  - Variability and micro/macro clumping properties
  - Structural properties (magnetized winds, colliding winds, discs, corotating regions, etc.)
  - Consequences on evolution, feedback, spectral synthesis

- Does the initial mass function vary with environment
  - Is there a universal upper stellar mass limit?
  - Is the stellar IMF the same in galaxies with much more intense star formation than MW?
  - What features are present in the integrated UV spectra of ‘resolved’ starbursts? (The diffraction-limited capability of a 12-m aperture is ~100 pc at z~3 to 4!)

Science case & requirements

Activity in Jan/Feb: scientific topics for whole LUVOIR mission

- Multiplicity in massive stars
  - Is the high binary fraction universal (vs. density, *Z*)?
  - Looking for the imprints of binary products in the UV spectra of unresolved star-forming systems
  - What is the impact of binary evolution on the rotational velocity distributions?
  - Link with the production of runaway stars?
  - Test predictions of chemically-homogeneous evolution in low-*Z* binaries as pathfinders of GW progenitors

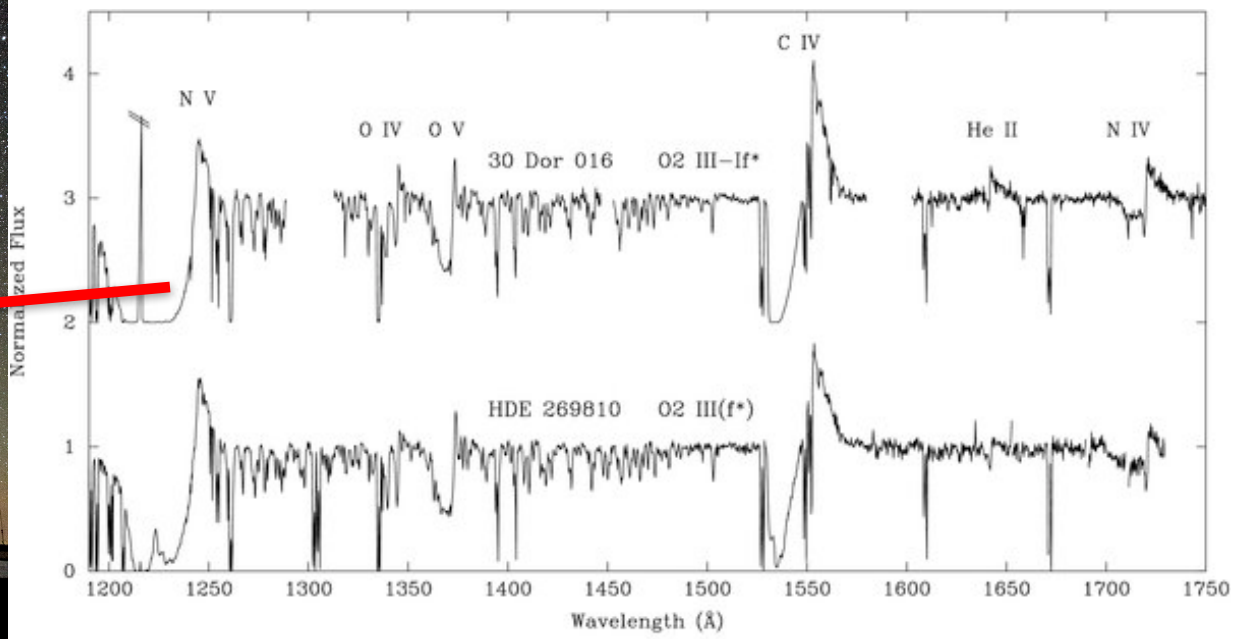
- Magnetic fields in massive stars
  - What is their role in evolution?
  - What is the impact of metallicity on the incidence and properties of magnetic fields?

- Circumstellar environments

Good mixture of POLLUX & LUMOS cases

For POLLUX this translates to...

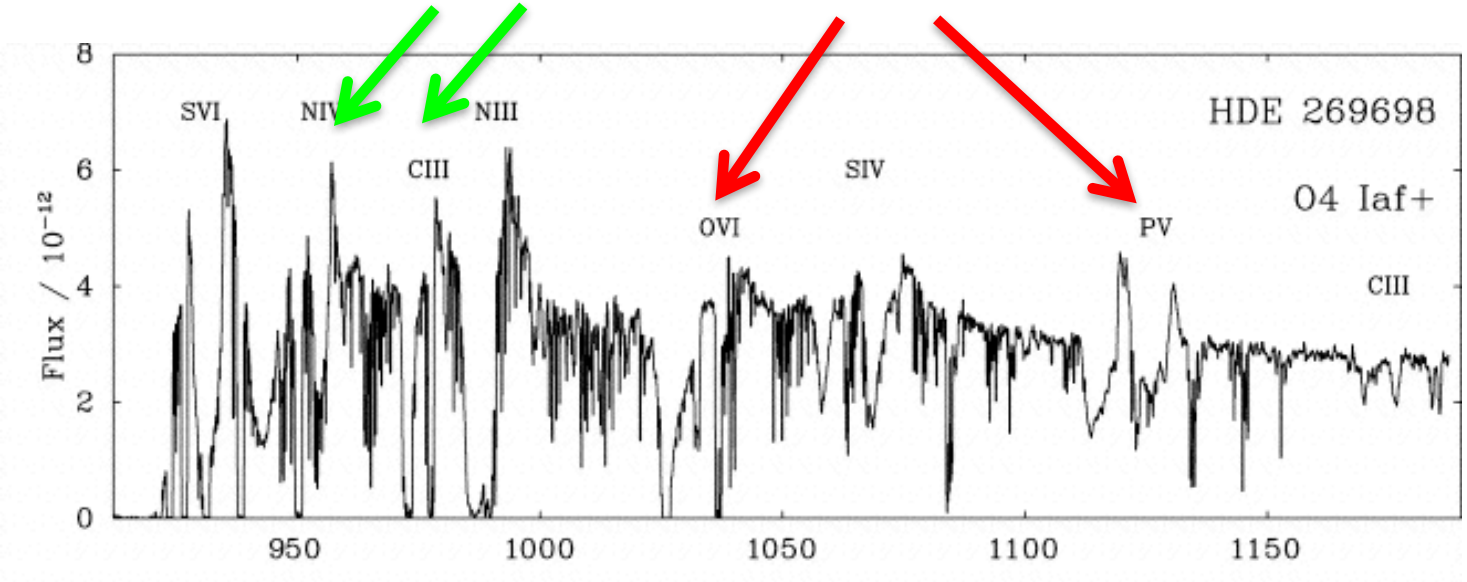
High quality, high-resolution spectroscopy of stars in the Magellanic Clouds (and Milky Way), to probe their winds, magnetic fields, and more…



e.g. Evans et al. (2010)

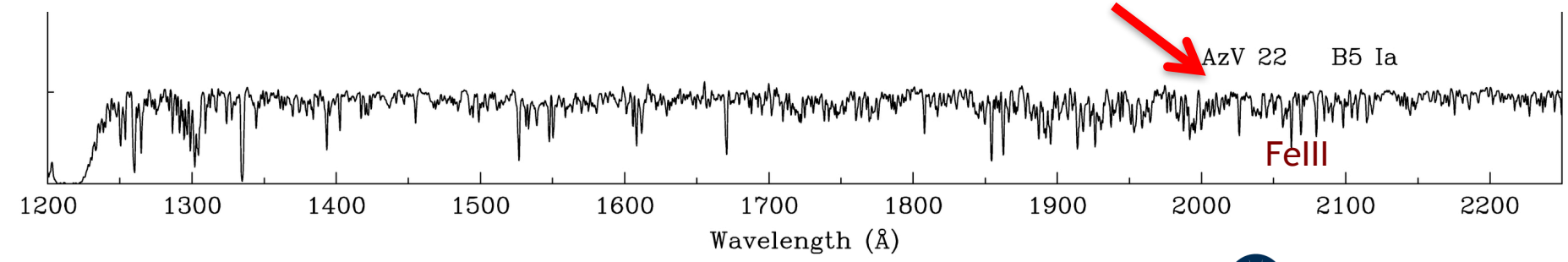
POLLUX requirements: wavelength coverage

Short cut-off: Desirable = 92nm; Essential = 100nm,



e.g. Crowther et al. (2002)

Longward cut-off: Essential = 210nm; Desirable = >280nm,



e.g. Evans et al. (2004)

POLLUX requirements

- Spectral resolving power: *R* > 80,000
  Resolving diagnostic lines in slowly rotating stars

- Magnitude of faintest targets: *V* ~ 15
  O-type dwarfs in Magellanic Clouds and LG

- S/N > 100 required:
  Dwarfs in Clouds in 2-3 hrs
  Galactic stars in 15-30 mins (avoiding short-term variability)

- Circular & linear polarisation (= unique capabilties) to 0.001% (*Arago M5*)

- Flux calibration: 1%
  To constrain energy distribution of stars cf. models

- Wavelength stability: ~1 km/s
  Not particularly critical cf. other POLLUX cases

In short, supporting rather than dimensioning case cf. others

LUVOIR requirements

Some Observatory level requirements surfaced:

- Pointing stability good enough to keep star stable within slit
  1-2 mas (TBC) – matched to diffraction limit at 100-150nm

- Operational incl target of opportunity (rapid-response) observations
  Flexibility to respond to other facilities: stellar activity, binaries, etc

- Scheduling capability for long-term monitoring programmes
  More like multi-epoch studies rather than intense 'campaigns'


Thanks!