



CGS4 - a breakthrough instrument

Phil Puxley
NSF

Outline

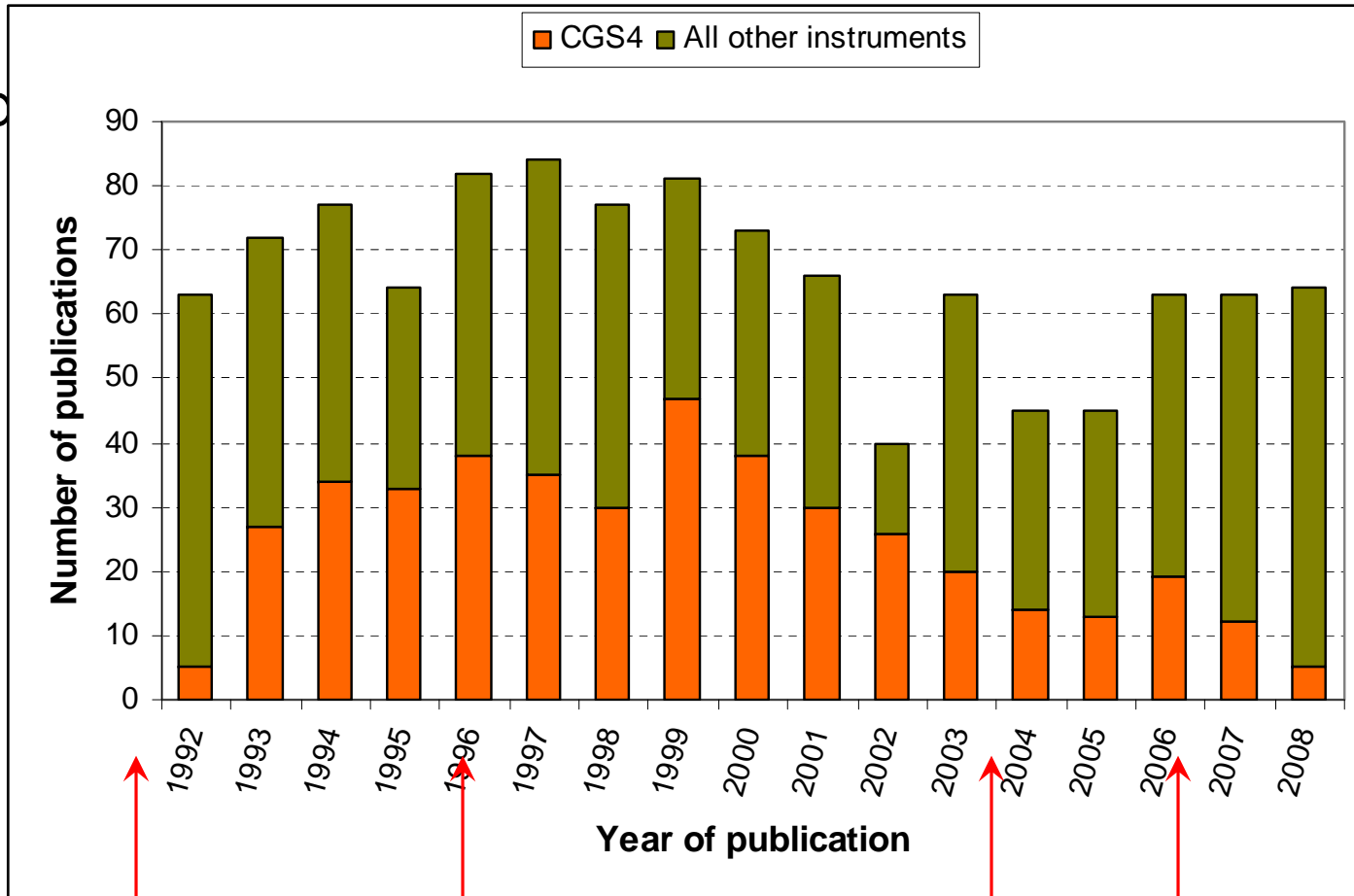
- Was CGS4 a breakthrough instrument?
- How was this achieved?
- Some science highlights



With thanks for input from: Alan Tokunaga, Bob Joseph, Bob Carswell, David Robertson, Tom Geballe, Gillian Wright, Andy Adamson, Ian Bryson, Jason Cowan, Peter Hastings, David Montgomery, Suzanne Ramsay, Matt Mountain

Was CGS4 a Breakthrough?

■ Inc



■ Forerunner for ROE/ATC engineering approach and large, complex instruments on large telescopes

commissioning 256 array upgrade UFTI & UIST WFCAM



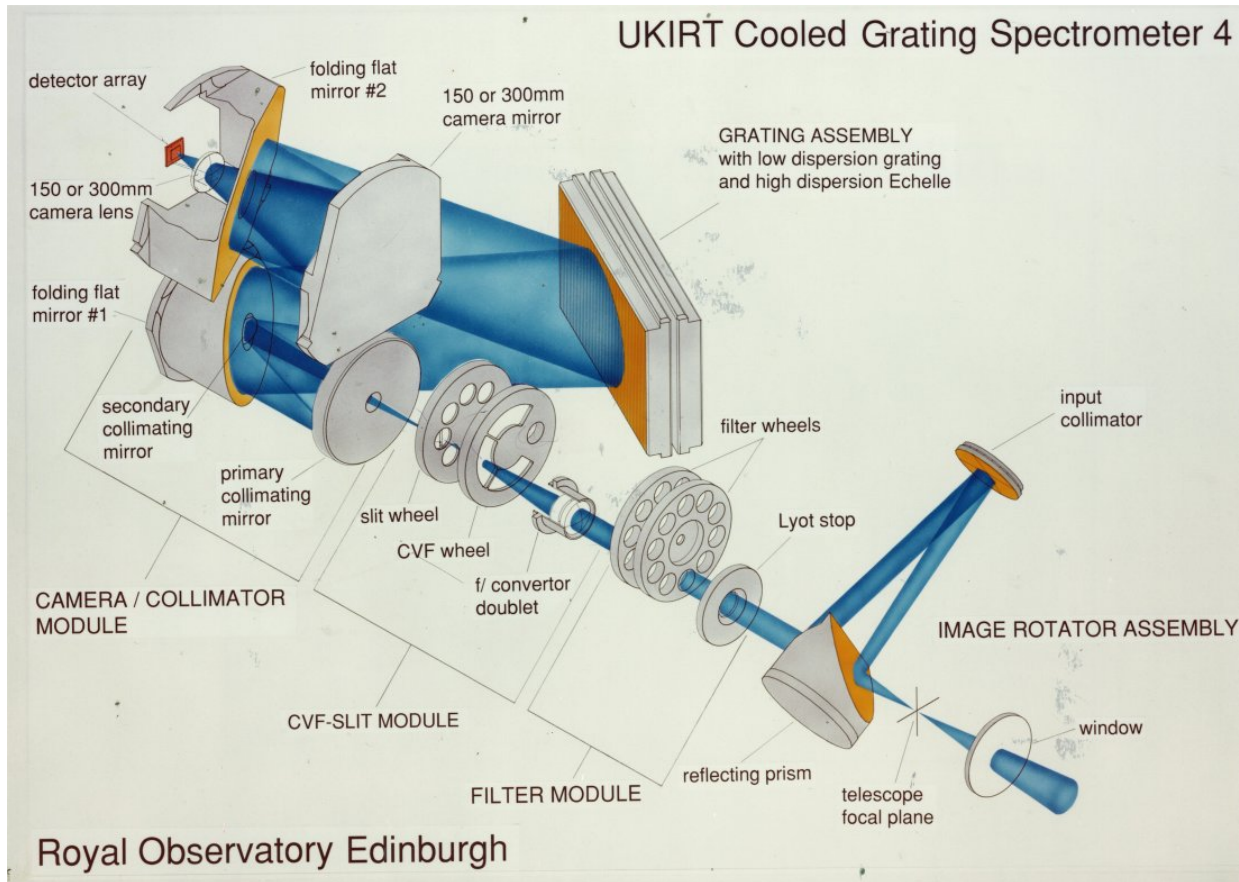
Why was CGS4 a Breakthrough?

- Engineering and technical innovations
- Management and team
- Integrated system including telescope and data processing

...each with many challenges

Why was CGS4 a Breakthrough?

■ Engineering and technical innovations



Original specifications (from R. Wade):

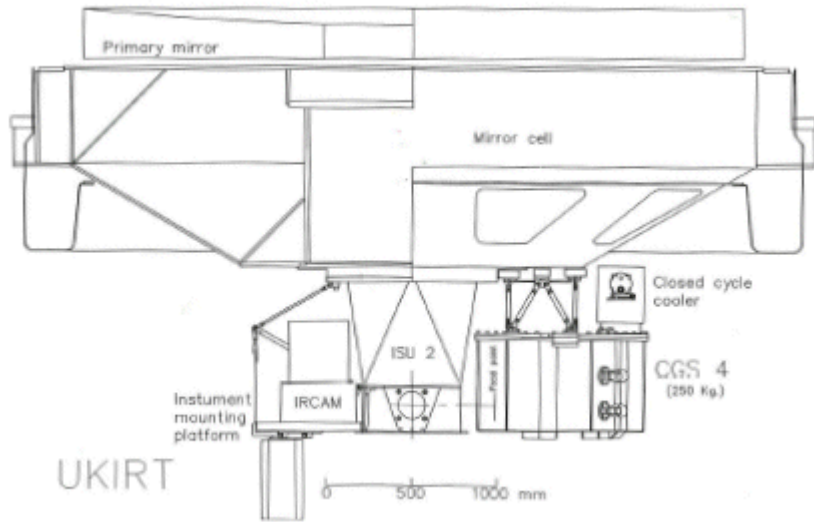
- Must fit in HD3-8 (CGS2-like) dewar
- Weight < 100kg
- Mount on existing UKIRT ISU
- Cost < 500k pounds
- Deliver in 4 years

As built (obeying laws of physics! ...3" slit & resn):

- Size ~ 1m
- Weight 250 kg
- Mounted to UKIRT mirror cell
- Cost ~3000k pounds (RDJ)
- Delivery in ~5 years

Why was CGS4 a Breakthrough?

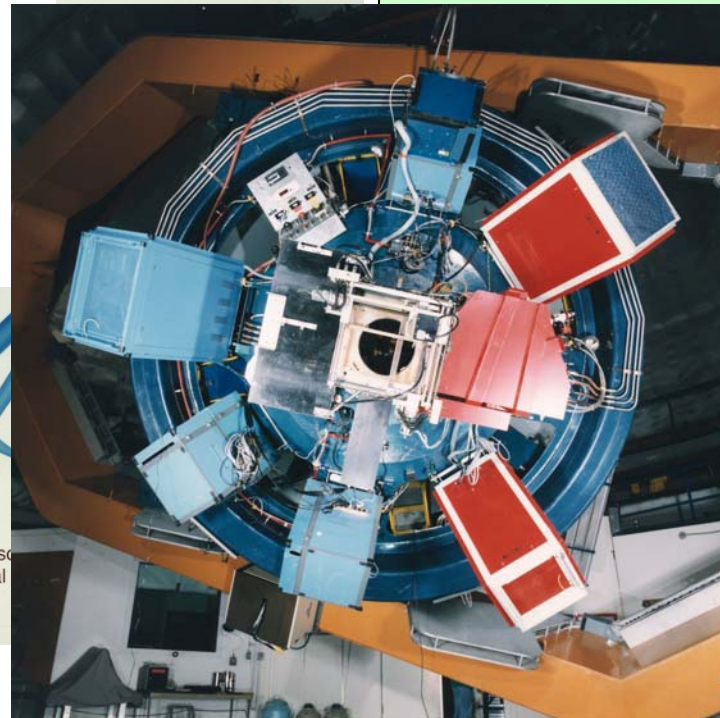
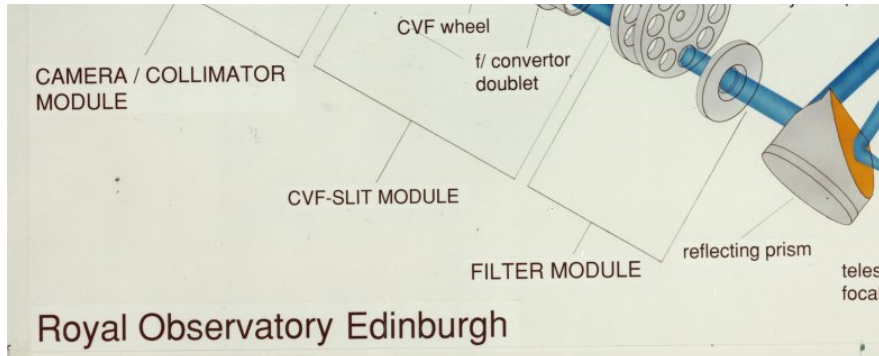
- Engineering and technical innovations



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UKIRT mirror

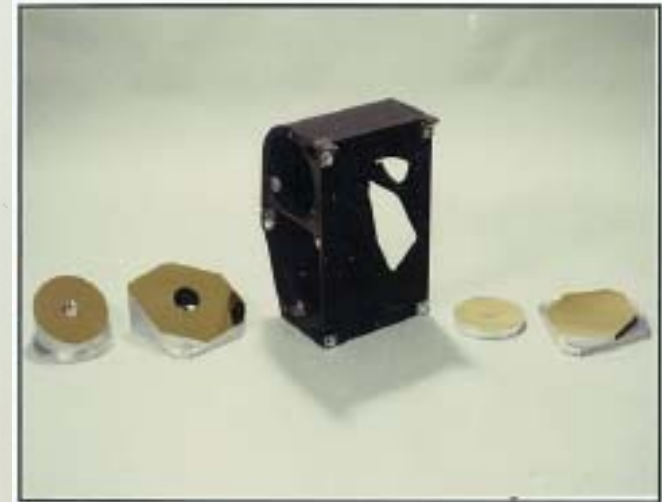
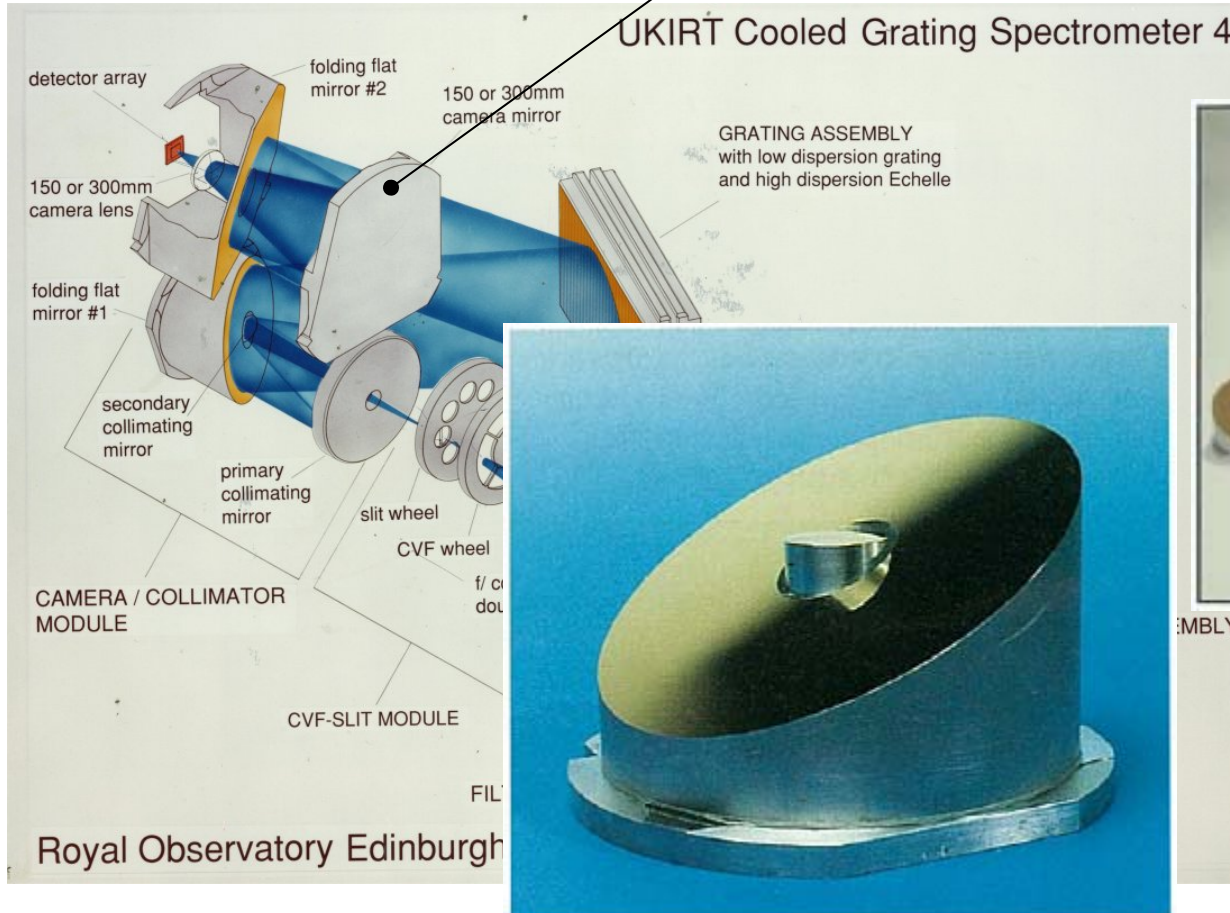
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Why was CGS4 a Breakthrough?

- Engineering and technical innovations

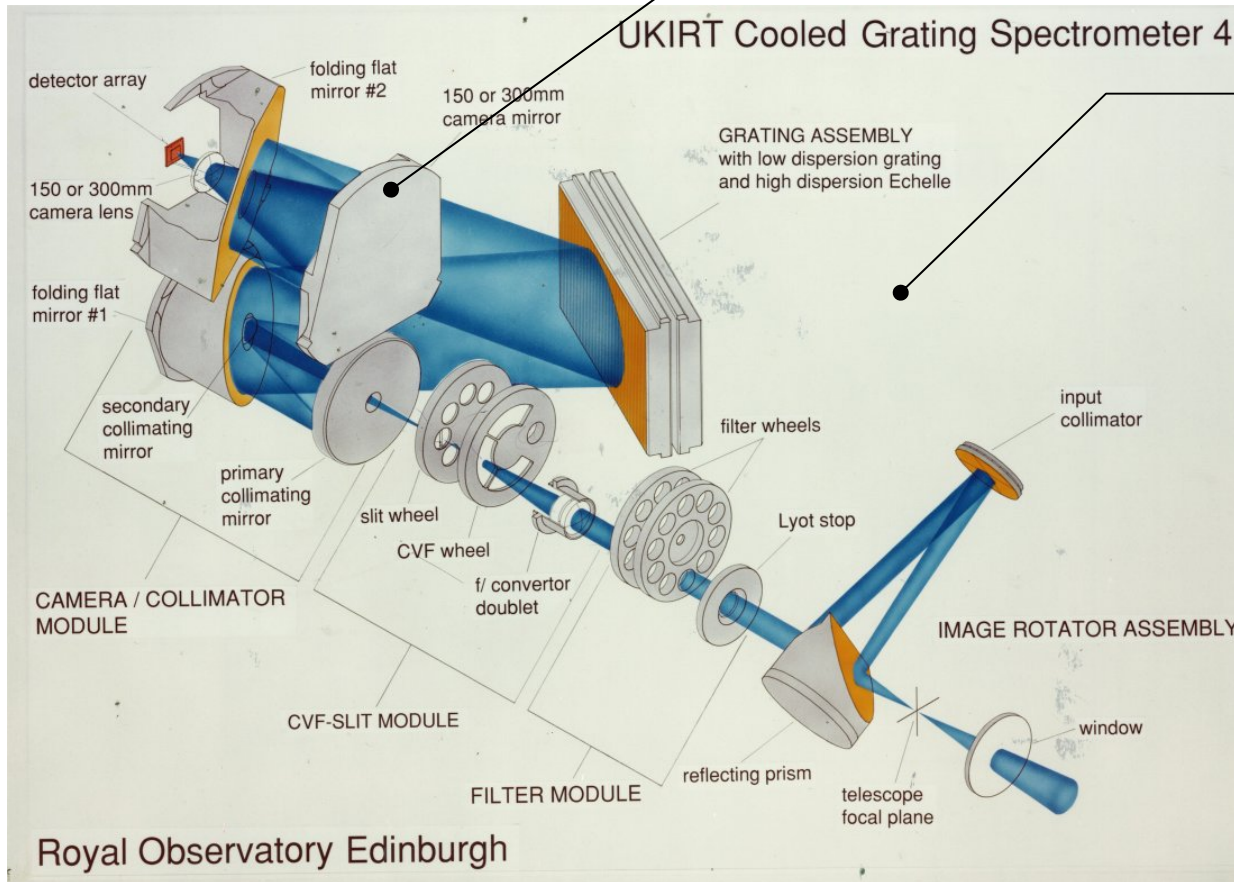
Diamond-machined metal aspheric optics (and planned upgrade path), mounts...



ASSEMBLY

Why was CGS4 a Breakthrough?

■ Engineering and technical innovations



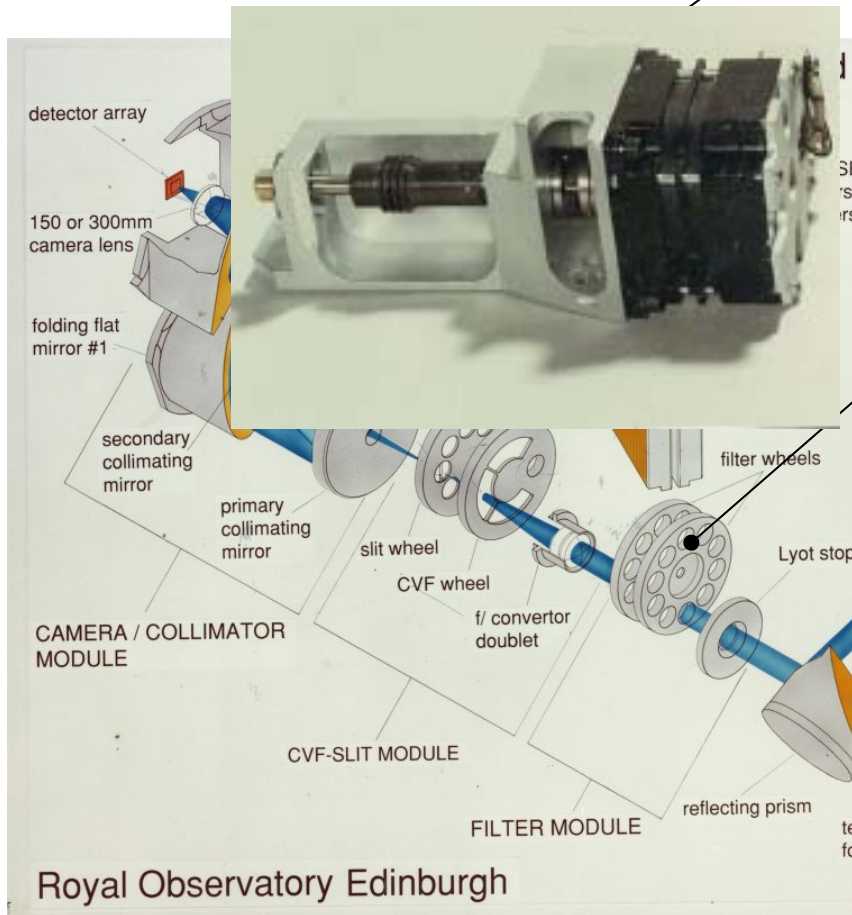
Diamond-machined metal aspheric optics (and planned upgrade path), mounts...

Aluminium structural casting



Why was CGS4 a Breakthrough?

■ Engineering and technical innovations



Grating Spectrometer 4

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Diamond-machined metal aspheric optics (and planned upgrade path), mounts...

Aluminium structural casting

Cryogenic stepping motors, vespel, bearings

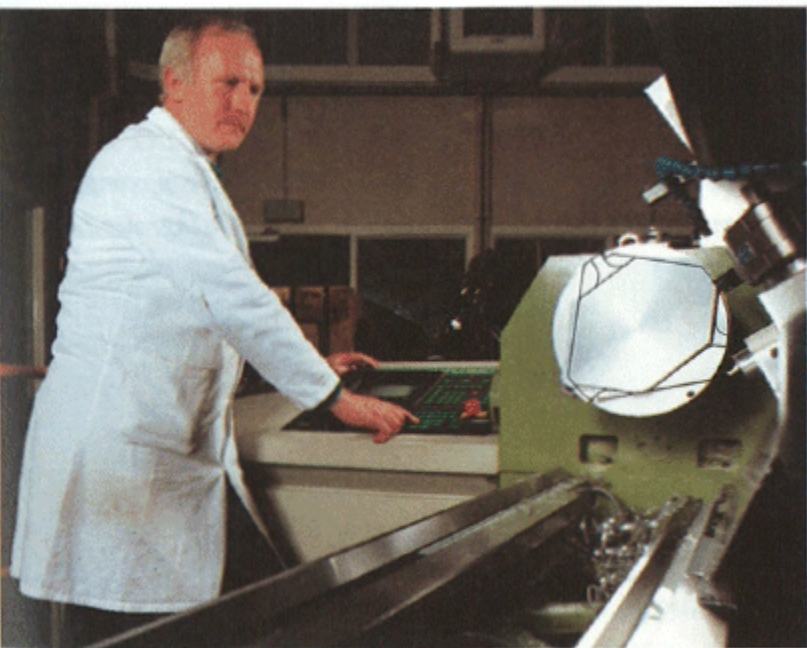


Why was CGS4 a Breakthrough?

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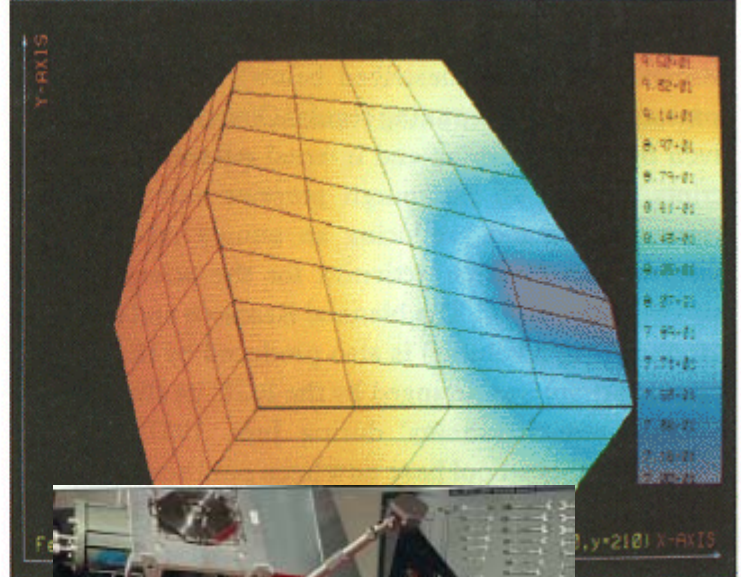
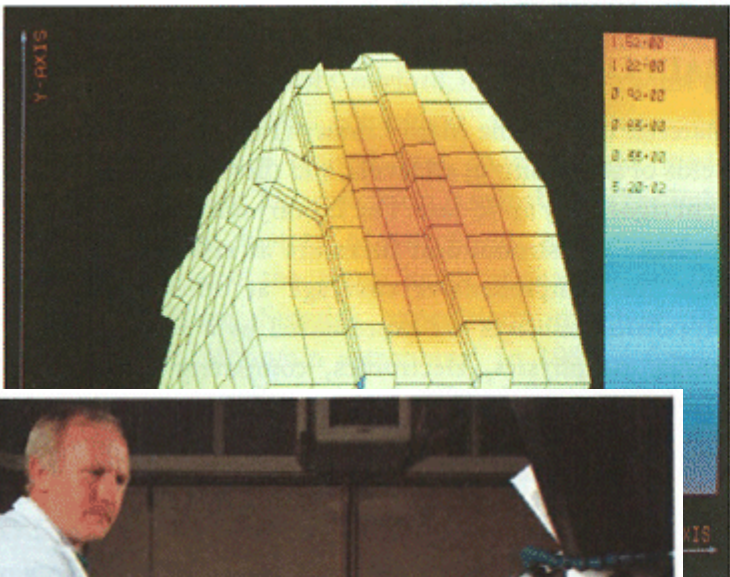


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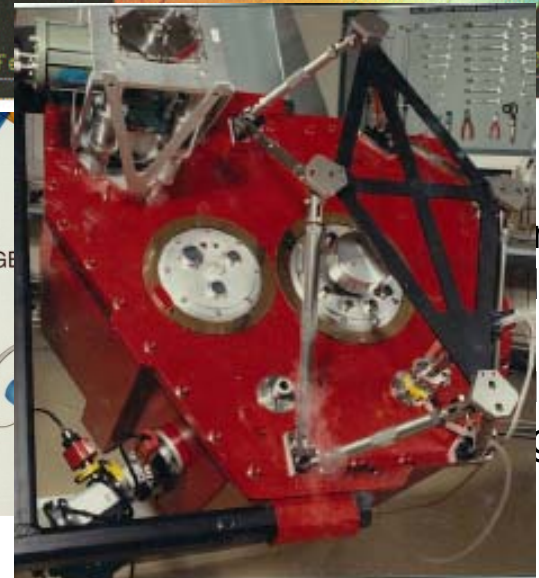
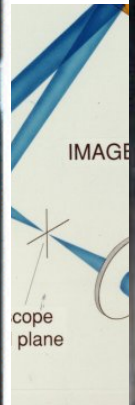
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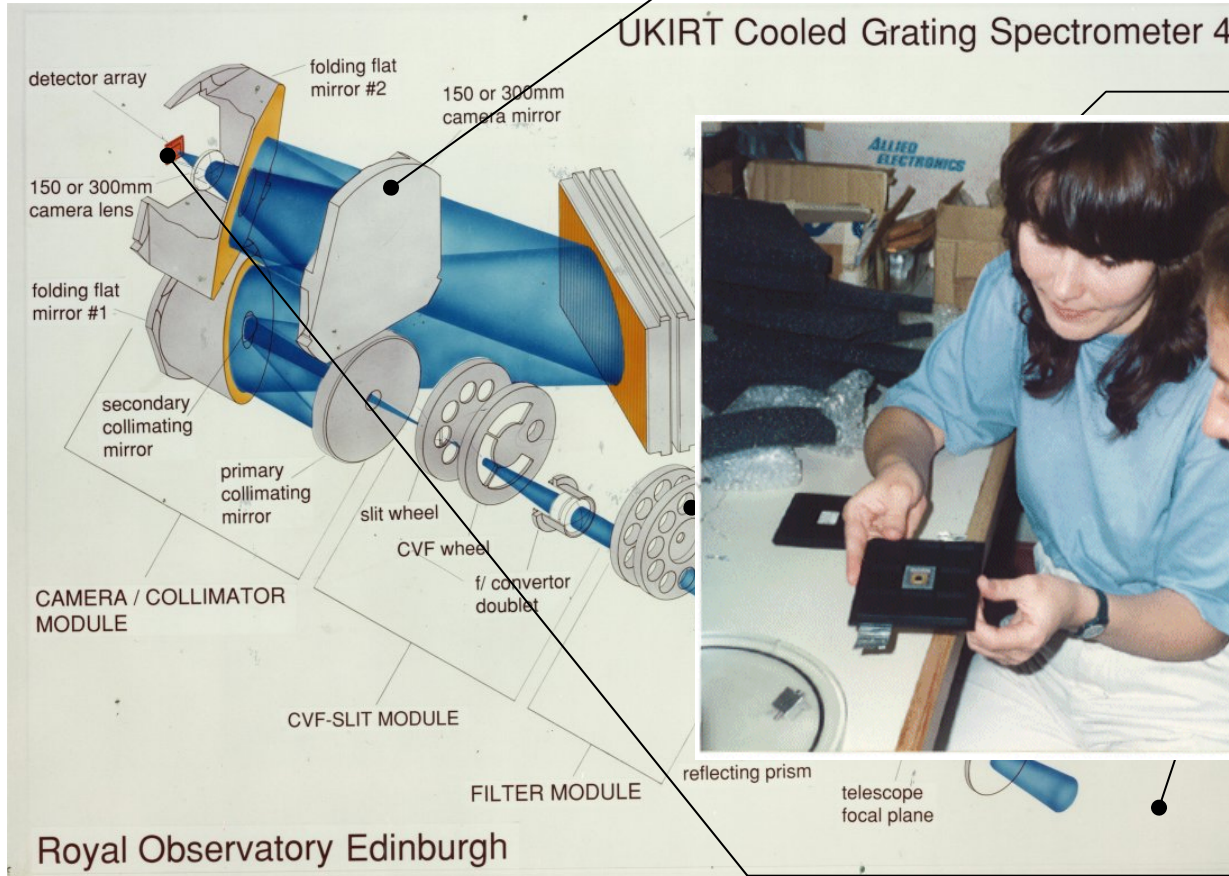
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Why was CGS4 a Breakthrough?

■ Engineering and technical innovations



Diamond-machined metal aspheric optics (and planned upgrade path), mounts...

Aluminium structural



slapping
el, bearings

cooler and
N2 system

thermal
, Monte-
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CNC, multi-axis
measuring machines...

Noise reduction (NDR),
det. translation, upgrade¹

Why was CGS4 a Breakthrough?

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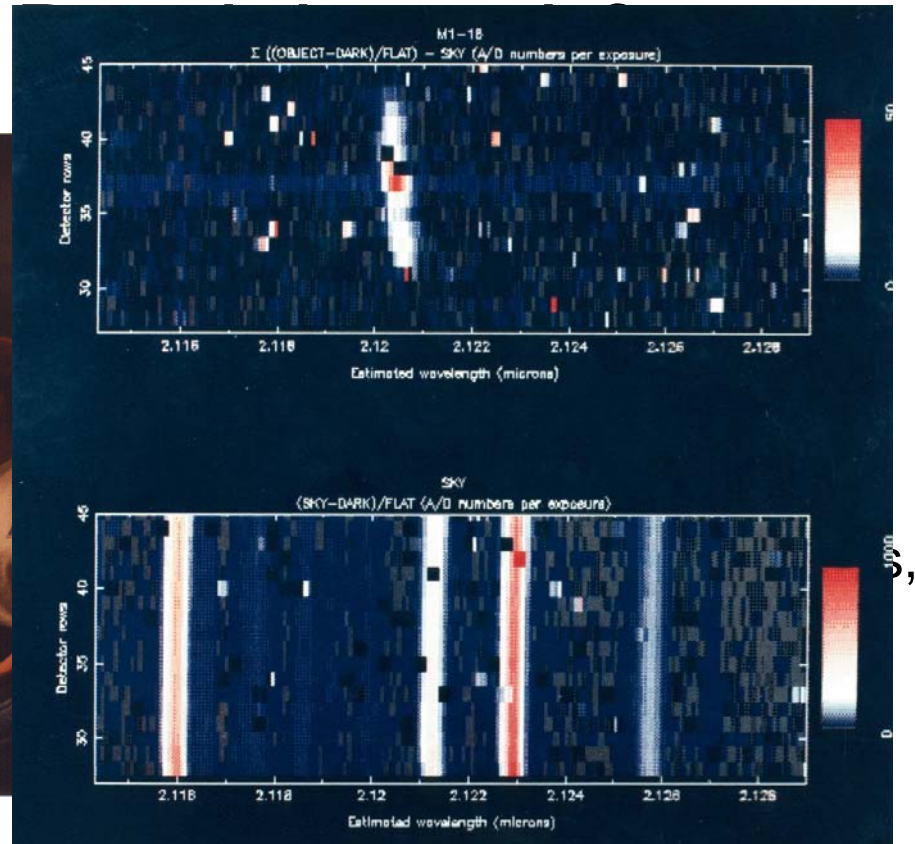
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Why was CGS4 a

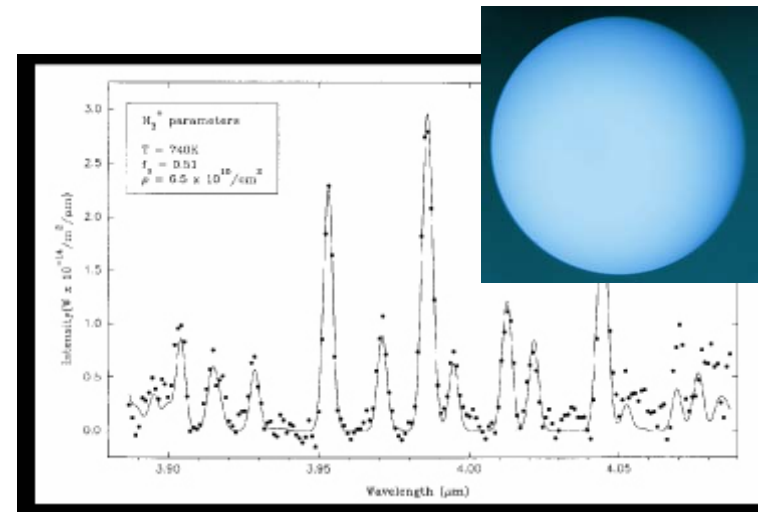
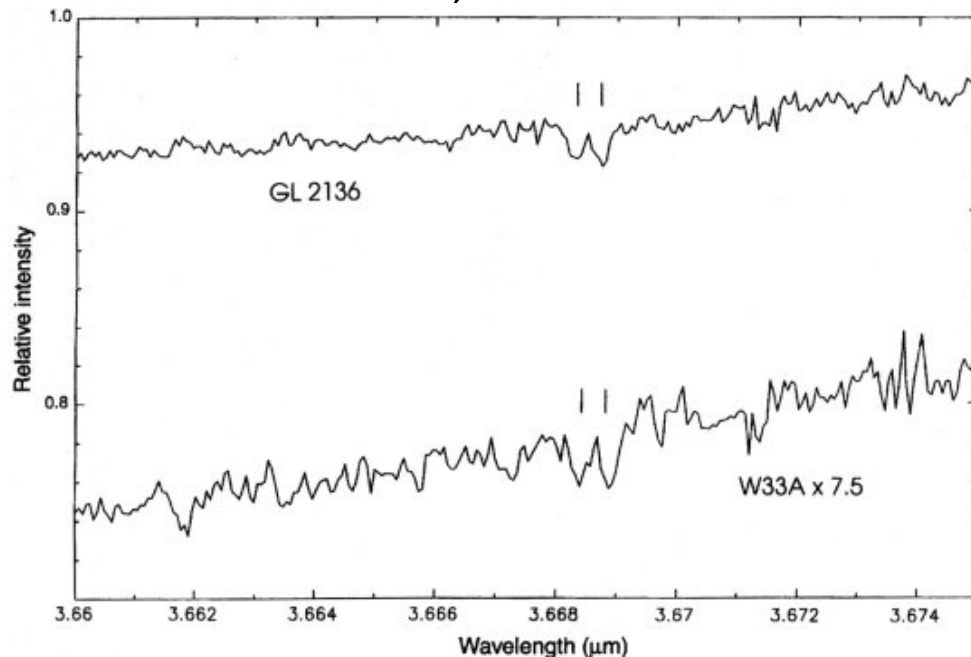


- CGS4DR data processing execution sequence and target identity (calibration, dark, arc, flat, object) in configurable processing sequence
 - Presented real-time 1D- and 2D-spectra optionally with background-subtraction, wavelength calibration, atmospheric correction...
- In combination, v. efficient data collection and real-time update of accumulated data for S/N and detection assessment

Some science highlights

■ H₃⁺

- T. Oka, T. Geballe et al.; see story in UKIRT Newsletter, 24, 7
- Pivotal role in gas phase chemistry; formation of CO, H₂O, NH₃, CH₄ etc
- Also observed in diffuse ISM, gas giant planets (exoplanet searches...)



Some science highlights

- B2 0902+34 $z=3.4$ radio galaxy
 - Eales, Rawlings et al. 1993 (Nature, 363, 140)
 - 0902+34 'red bump' from PMS stars may be confused by redshifted [OIII] lines - galaxy (furthest known in late 80s)

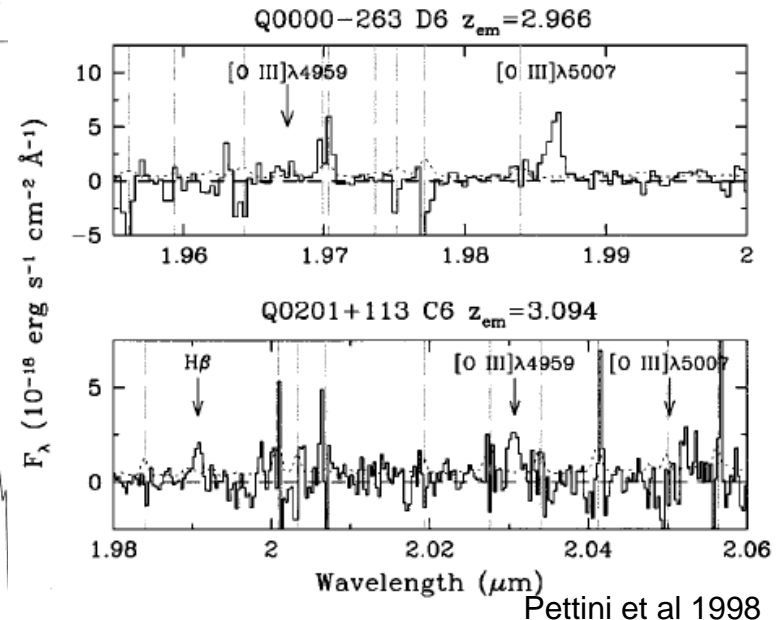
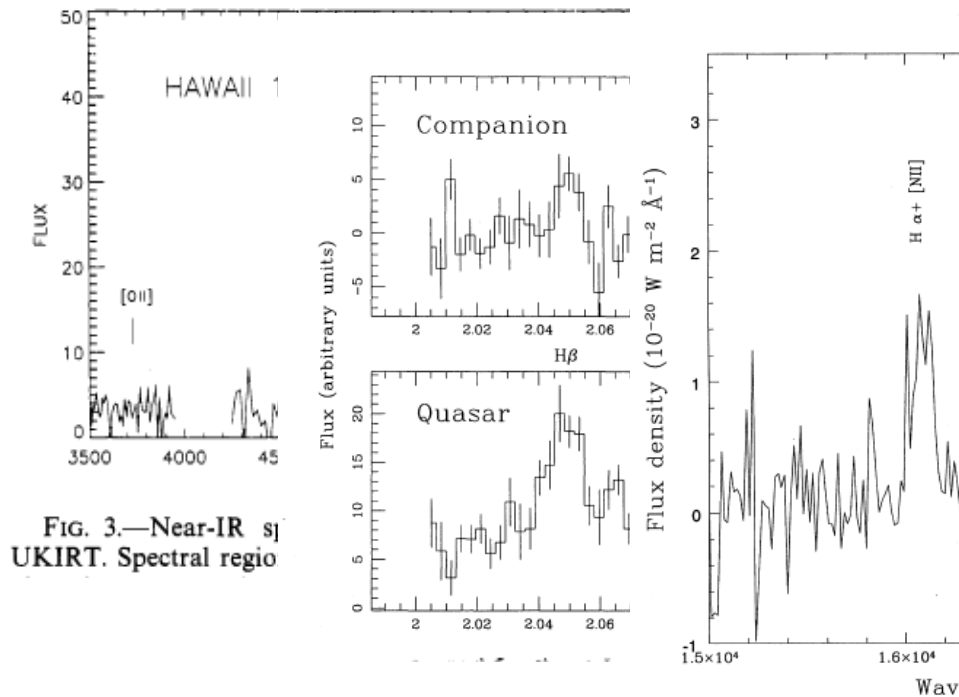


FIG. 2.—Portions of the UKIRT spectra of $z \approx 3$ Lyman break galaxies secured during the 1996 September observing run. The positions of the

Some science highlights

- Spectral sequences of stars at the bottom of the IMF

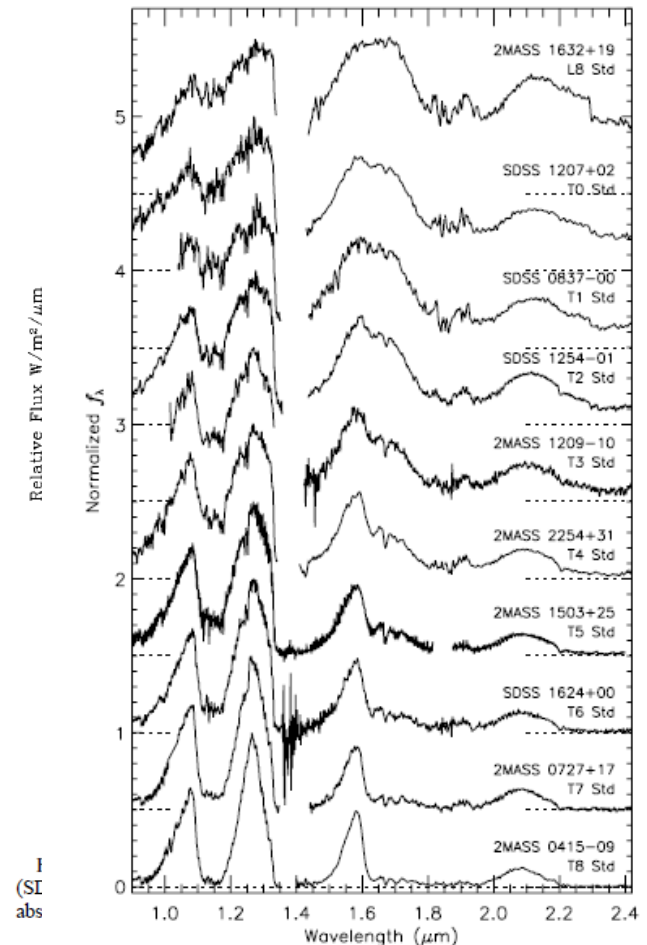
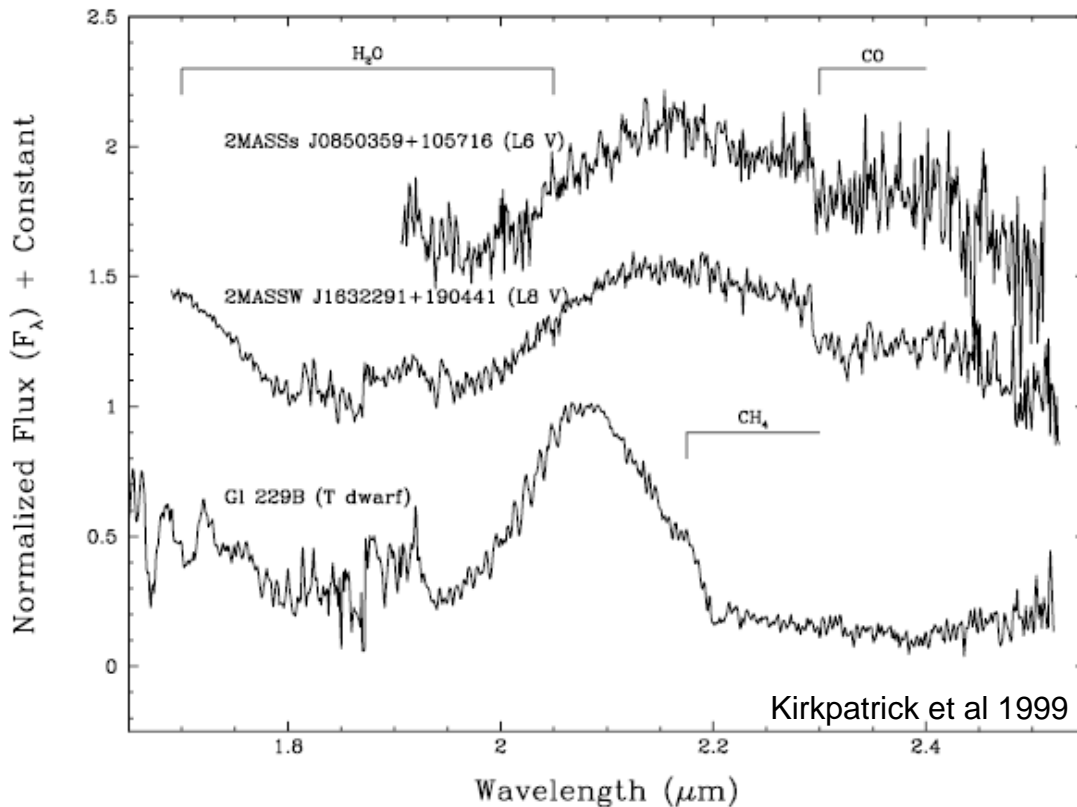


FIG. 5.—Near-infrared spectra of the two coolest 2MASS L dwarfs, taken with CGS4 on UKIRT. Also shown for comparison is the Geballe et al. (1996) spectrum of the only known T dwarf G1 229B, also taken with CGS4 on UKIRT. The flux scale is in units of F_λ , normalized to one at 2.20 μm . Integral offsets increasing importance of water absorption.

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Summary

- CGS4 was a breakthrough instrument because of
 - Engineering and technical innovations driven by science goals
 - Strong technical and science team encouraged to exploit new processes as necessary
- ...led to more than a decade of top-ranked science
- ...and was a forerunner for the current generation of large, complex instrumentation

