Early spectroscopic innovation at the RAL

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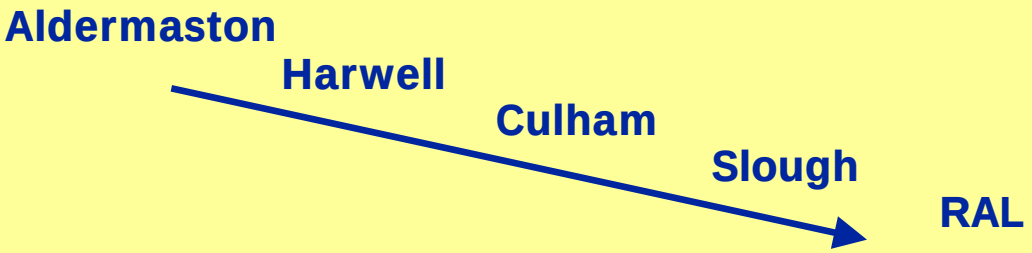
Heritage of this work

Scientists - **from parent government laboratories 1960-1975**

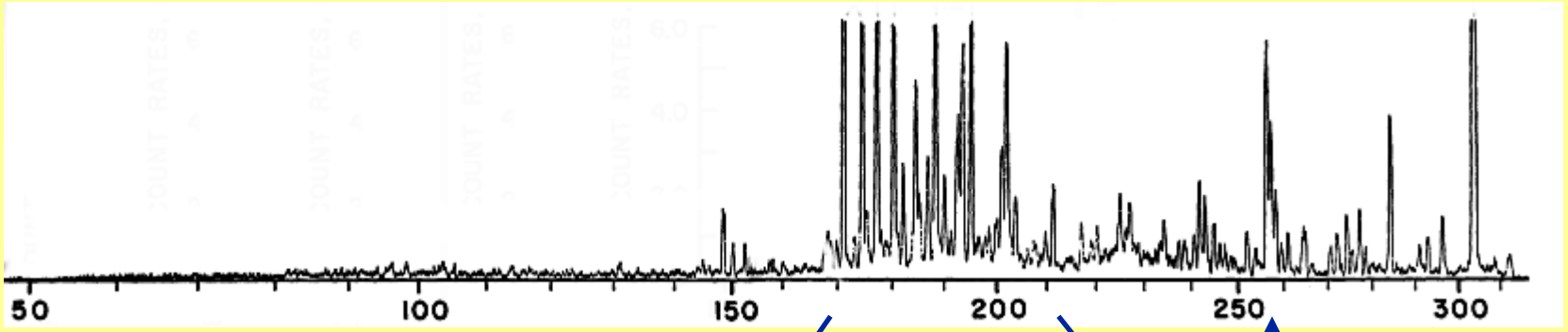


Science - **Spectroscopic diagnostics of hot plasma for Thermonuclear research,**

Sources - **Thermonuclear - ZETA, theta-pinches, Z-pinches, Laser-produced plasmas**
- **Specialist, vacuum sparks, dye-laser, others**

Spectrometers - **Grazing-incidence, Crystal diffraction (both for lab research and space)**

The solar extreme UV spectrum in 1964 (Heroux and Hinteregger)

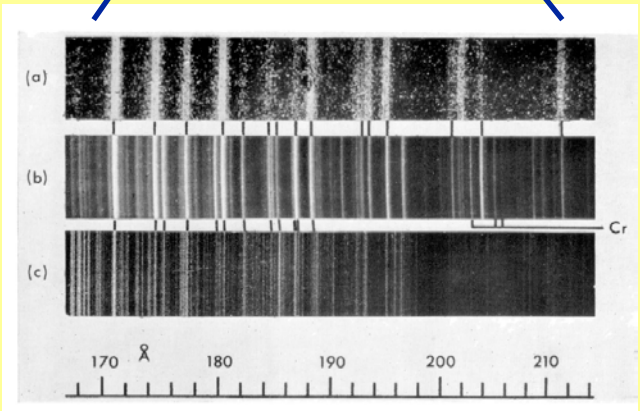


RAL spectra :

Sun

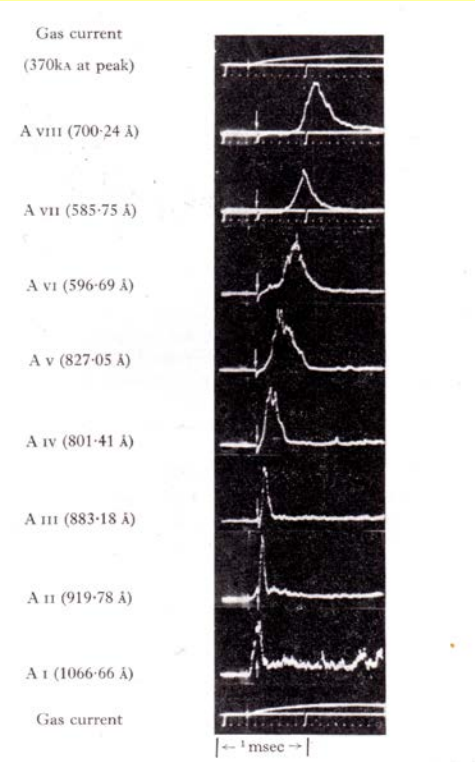
ZETA

iron spark



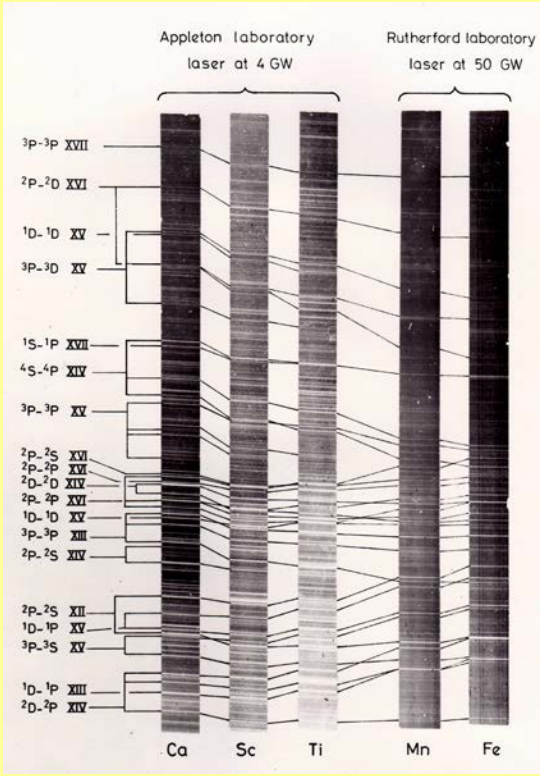
Techniques for identifying spectra

Temporal ionization series



Identification of ionization stage

Iso-electronic series



Theoretical methods insufficient for absolute wavelengths, but reliable for trend with charge Z.

Configuration interaction in Z-series

In this example, due to mixing between 4s and 3d configurations, when close to the crossing points.

Other cases occur between 4f and 3D configurations.

Only when this is taken into account, can the group of lines be fully identified.

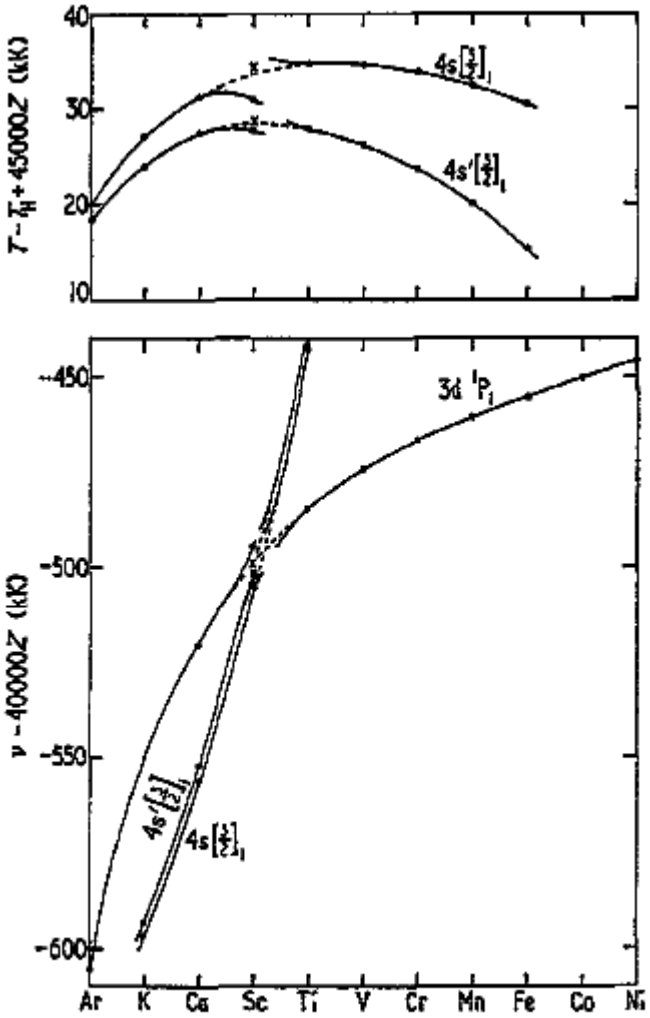
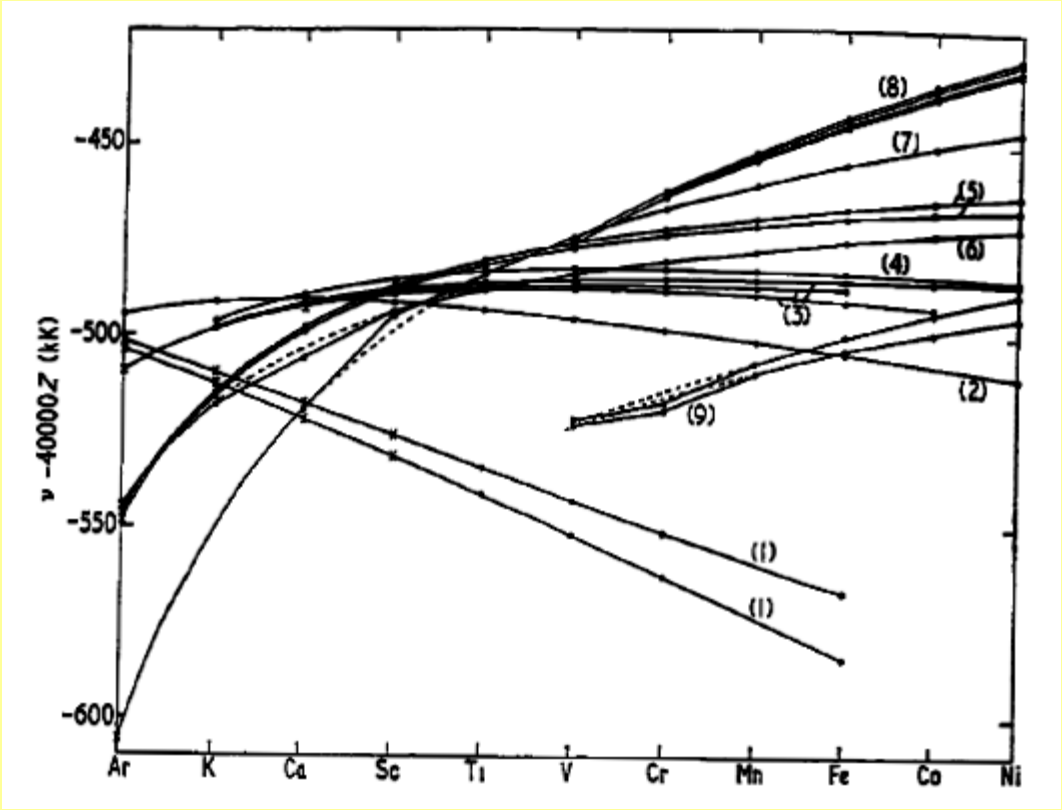


Figure 3. Ar I sequence term values.

Final set of these lines from argon to nickel



Because of their temperature dependence, the same as the solar corona, these lines continue to be used for solar spectroscopy in new observations.

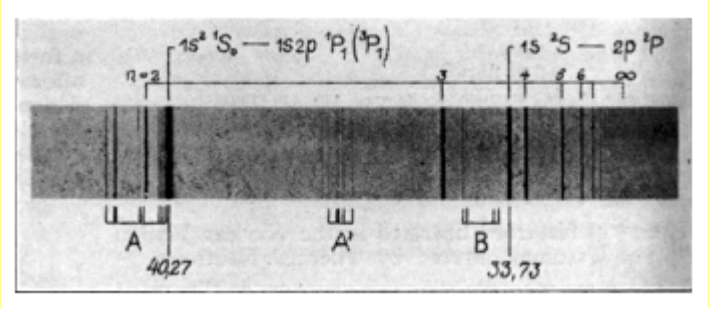
In particular for the EIS solar spectrometer flying on the mission HINODE

Dotted portions show where configuration interaction is important

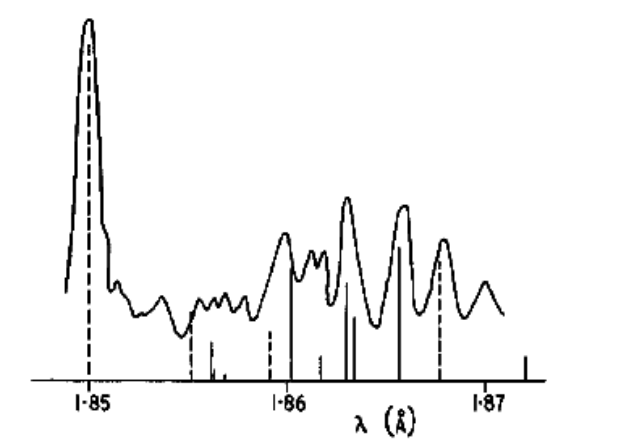
Dielectronic satellite spectra

First observed by Edlén and Tyrén in 1939.

They correctly identified the configurations responsible, but were unable to explain the excitation mechanism, nor interpret their intensities.



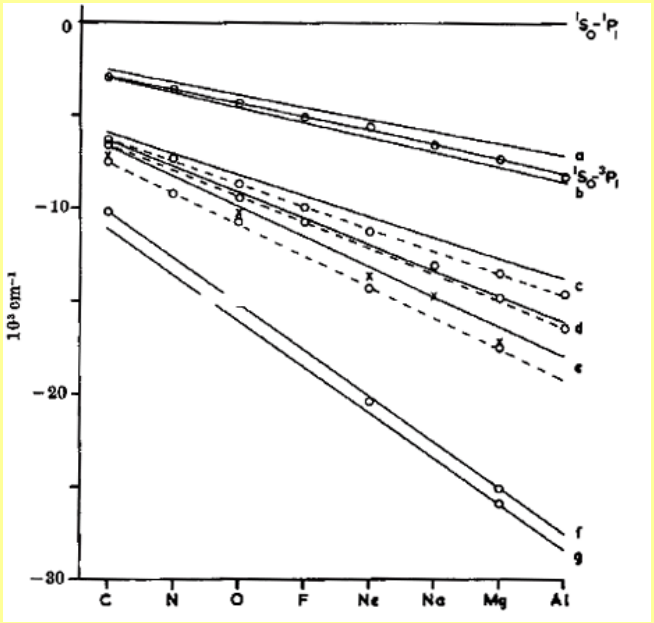
Next observed in 1971 in solar flare spectra of iron, from the Russion Intercosmos spacecraft. The identifications are from our RAL group.



Dielectronic satellite spectra

Theoretical work carried out at RAL led to:

1. The precise predicted wavelengths and



For the isoelectronic series

2. A theory for the intensities

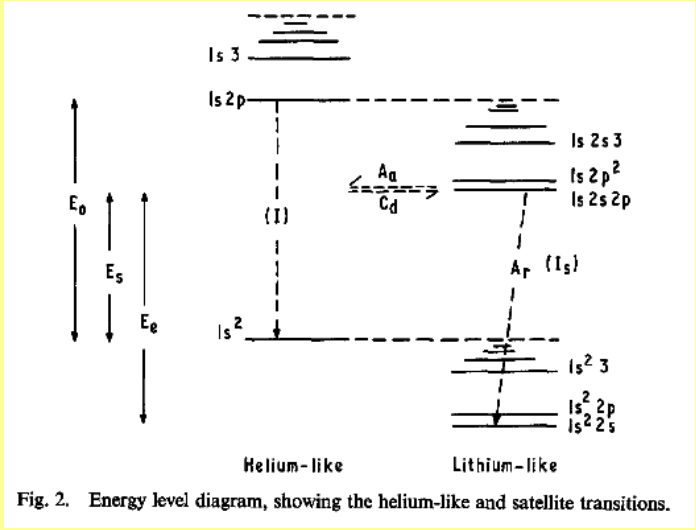


Fig. 2. Energy level diagram, showing the helium-like and satellite transitions.

leading to a diagnostic for temperature and ionization state

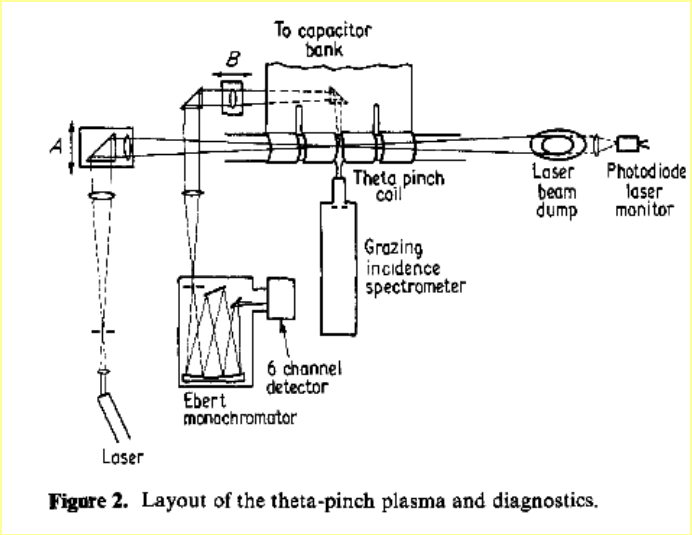
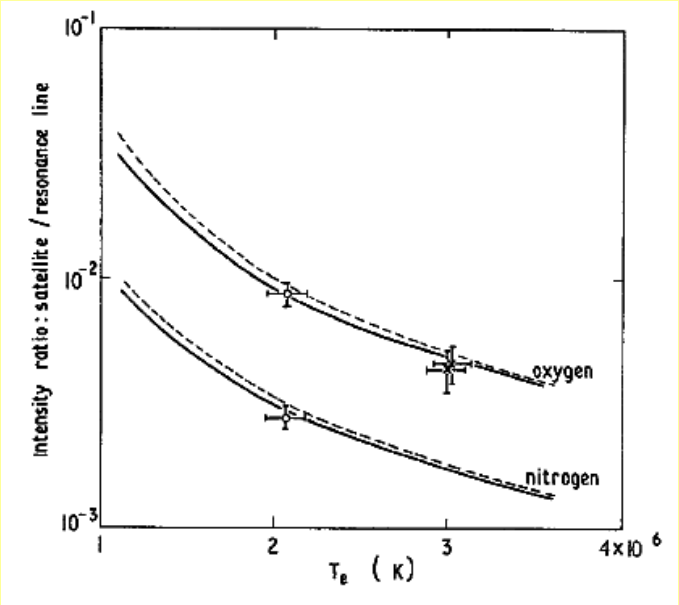


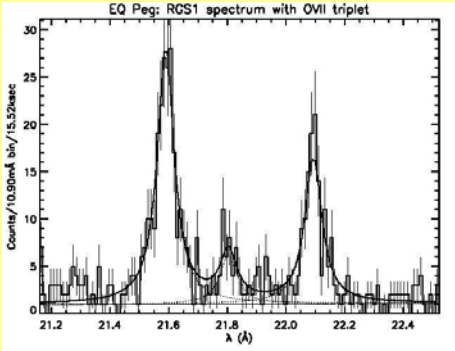
Figure 2. Layout of the theta-pinch plasma and diagnostics.



Cosmic X-ray astronomy Missions

Dielectronic satellite work carried out at RAL led directly to the design concept for two new space missions, both launched in 1999.

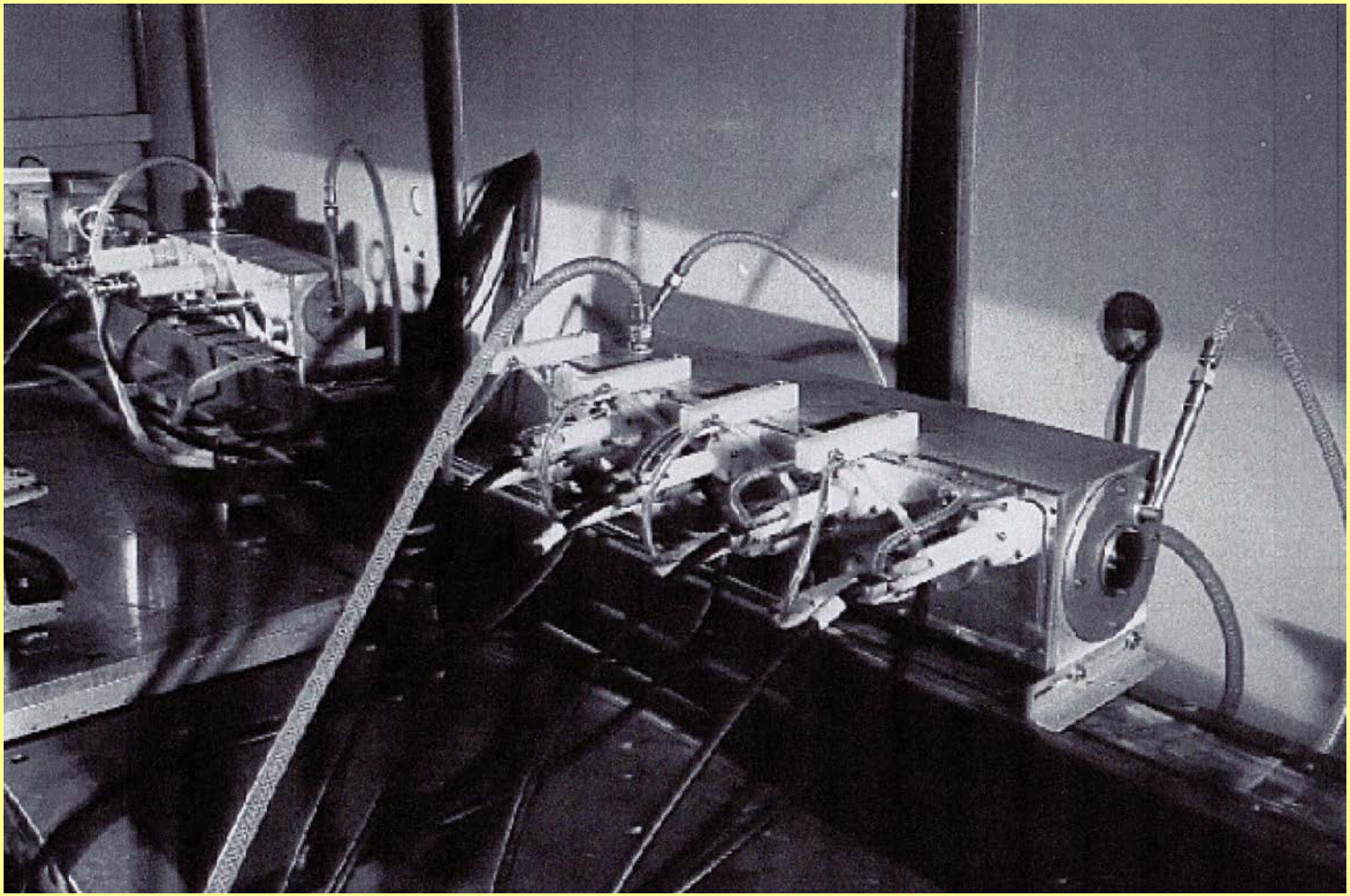
XMM Newton mission of ESA

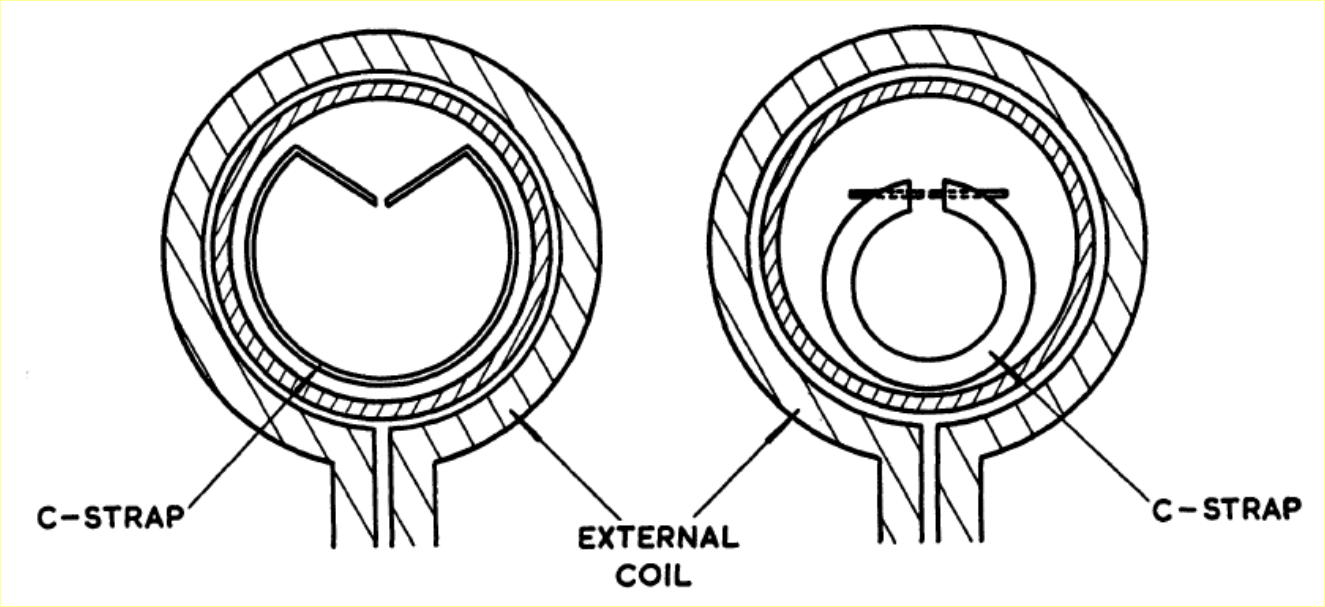


Chandra mission of NASA

other RAL scientists involved in this program:

Brian Fawcett
Carole Jordan
Peter McWhirter
Robert Wilson

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