JD20

Frontiers of High Resolution Spectroscopy

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Introducing Joint Discussion 20: Frontiers of High Resolution Spectroscopy

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Abstract. This paper introduces the rationale and program of Joint Discussion 20, Frontiers of High Resolution Spectroscopy, which took place on 2003 July 23–24 during the IAU General Assembly in Sydney Australia.

1. Rationale for Joint Discussion 20

Major discoveries in astrophysics are usually enabled by significant increases in observing capability – enhanced sensitivity, larger spectral coverage, higher temporal resolution, long-term monitoring, decreased noise or background, better angular resolution, and higher spectral resolution. The expectation of important future discoveries that become possible with enhanced observing capabilities is a major driver for the building of new instruments and telescopes.

In recent years we have seen a plethora of new high visibility projects that push forward the observational frontiers toward greater throughput for imaging and low-resolution spectroscopy, improved spectral coverage, and higher angular resolution. There have also been major advances in spectral resolution, although with less publicity and recognition in the astronomical community. Joint Discussion 20 was motivated by the desire the highlight the accomplishments and opportunities of high-resolution spectroscopy across the electromagnetic spectrum. The objectives of this Joint Discussion include

(1) presenting a representative sample of new results that provide insights into major questions in astrophysics by pushing the limits of high-resolution spectroscopy,

(2) speculating about major questions that could be addressed with new advances in high-resolution spectroscopy, and

(3) discussing cross-cutting technologies and data analysis techniques that may apply across the electromagnetic spectrum.

Symposia, colloquia, and workshops in astrophysics are often narrowly focused on specific phenomenola, targets, or theory. The uniqueness and virtue of the program of Frontiers of High Resolution Spectroscopy is that it cuts across many topics in astrophysics to concentrate on the common theme of high-resolution spectroscopy — what it has accomplished, and what it can accomplish with new instrumentation. The following papers describe high-resolution spectroscopy as a unique tool for understanding the physical properties of astronom-

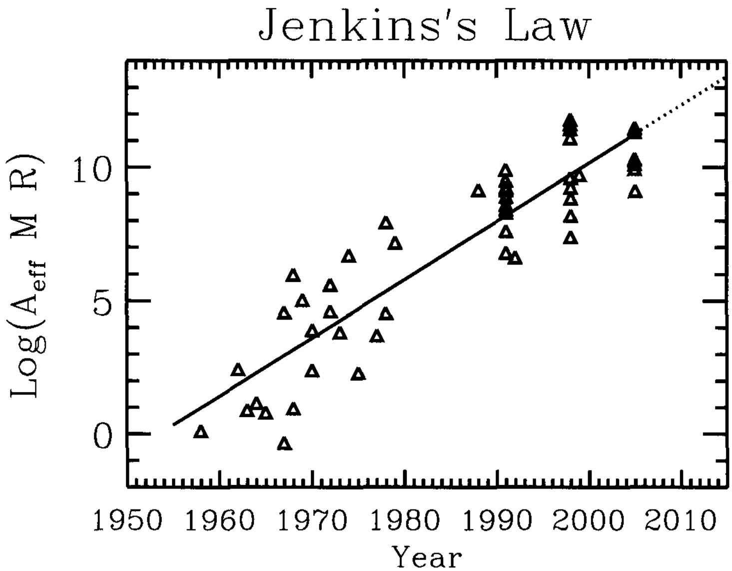

Figure 1. Jenkins's Law is a figure of merit describing the capabilities of UV spectrographs and telescopes with time. This figure is an update of a figure originally presented in Jenkins (1999) and kindly provided by the author.

ical sources — their velocity structures, temperatures, densities, and chemical compositions.

The capabilities for high-resolution spectroscopy of astronomical targets are rapidly increasing with developing technology. As described in more detail by Jenkins in his paper that follows, a useful figure of merit for high-resolution spectroscopy is the product $A_{\rm eff}MR$, where $A_{\rm eff}$ is the effective area, M is the number of independent spectral channels, and $R \equiv \lambda/\Delta\lambda$ is the spectral resolution. As shown in Figure 1, $A_{\rm eff}MR$ for UV spectrographs and telescopes is doubling every 16 months. Jenkins's law is even steeper than Moore's law for the increase in the number of transitors on a chip. Similar plots could be constructed for other wavelength regions. The challenge we face is how to harness this rapidly developing technology to astrophysical research.

2. Implementation

The program was created by the Scientific Organizing Committee: John Bally (USA), Roy Booth (Sweden), Nancy Brickhouse (USA), David Gray (Canada), Jeffrey L. Linsky (Chair, USA), Gautier Mathys (Chile), Michel Mayor (Switzerland), Roberto Pallavicini (Italy), Nikolai Piskunov (Sweden), and Alfred Vidal-Madjar (France).

The program highlighted the astronomical results of high-resolution spectroscopy and other observational techniques that achieve high wavelength or

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velocity resolution. For example, subdiffraction limited imaging is now achievable through Doppler imaging and other tomographic techniques that require high spectral resolution data with high signal-to-noise and excellent velocity precision.

Joint Discussion 20 presented recent accomplishments and future instrument plans for high-resolution spectroscopy of astronomical sources across the electromagnetic spectrum. At all wavelengths, increased spectral resolution with high throughput is yielding new information on the chemical composition, velocity structure, and physical properties of astronomical sources. As described in the papers that follow, "high resolution" means different things in different spectral regions depending on instrumental capabilities and the properties of the targets observed. New instruments on ground-based and space telescopes will greatly increase these capabilities. The objectives of the joint discussion are to highlight these developments and to present some of the new techniques in instrumentation and data analysis that cross artificial boundaries of wavelength and scientific topic.

The following sixteen papers are short versions of the papers presented at the Frontiers of High Resolution Spectroscopy meeting spanning the electromagnetic spectrum from gamma rays to long wavelength radio astronomy.

I thank Dr. Ed Jenkins for the use of Figure 1 and NASA for support at this meeting.

References

Jenkins, E. B. 1999, in Chemical Evolution from Zero to High Redshift, eds. J. R. Walsh & M. R. Rosa (Berlin: Springer), 280