《积分视场光谱仪》教案

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一、教学目标：

1. 了解积分视场光谱仪的原理
2. 了解IFS的结构和data-cube
3. 了解IFS的应用，MUSE

二、教学重难点：

data-cube 和 IFS结构

三、学习者分析

大学三年级天文专业本科生，少数跨选或者辅修天文学的理科大三和大四本科生

四、教学准备

多媒体教室，PowerPoint 课件

五、教学过程

1. 教学时间安排（总时长 10’）

   1’导入

   3’什么是IFS

   1’为什么有人会造IFS

   3’IFS应用

   2’ 视频放送

2. 导入课程

   我想大家应该都记得滤波片是干什么的，我们对于一个天体进行观测，可以用不同滤波片挡住光路，我们就可以以此得到不同波长的单色光图像，但是这样做有一个非常大的不便，就是我们要得到一张图像就需要观测一次，对于暗弱天体我们还需要进行长时间曝光，这个过程就显得十分漫长，那么我们能不能实现一次观测就可以得到图像和光谱信息呢？

   当然可以！今天就为大家介绍能完成大家这一想法的仪器：积分视场光谱仪。

3. 什么是IFS

lenslet array：The input image is split up by a microlens array (MLA). Light from each element of your observed object is then concentrated into a small dot and dispersed by the spectrograph. Because the dots are small it is possible to tilt the MLA about the optical axis of the system so that the spectra do not fall on top of each other, thus allowing the input image to be sampled contiguously (differentiating this technique from slit-less spectroscopy). The disadvantage is that the length of spectrum that can be produced without overlapping is very small and the packing of the CCD is not that efficient. [1]

Fibres (with or without lenslets):this is currently the most common technique in use. The input image is formed at the entrance to a 2D bundle of optical fibres which transfer the light to the slit of the spectrograph. The flexibility of the fibres allows the round/ rectangular field-of-view to be reformatted into one (or more) "slits", from where the light is directed to the spectrograph, and the spectra are obtained without wavelength shifts between them. The disadvantages of this techniques are: (a) the sampling of the sky is not contiguous since there are gaps between the fibre cores (fibres are cylindrical) and (b) the fibres do not work efficiently at the slow focal ratios at which most telescopes work resulting in focal ratio degradation (FRD). Disadvantage (a) can be overcome by placing an array of contiguous lenslets in front of the fibre bundle in order to focus all the light collected by that lenslet into the fibre (lenslet shapes are usually square or hexagonal and thus can be packed contiguously). An additional benefit of this variation is that the microlenses slow the telescope focal beam so that FRD can be minimised. [2][3]

Image-slicer:The input image is formed on a mirror that is segmented in thin horizontal sections, sending each 'slice' in slightly different directions. A second segmented mirror is arranged to reformat the slices so that, instead of being above each other they are now laid out end to end to form the slit of the spectrograph. The advantage of this technique is that FRD is avoided and the slicing arrangement gives contiguous coverage of the field at potentially high spatial resolution. Because this system uses only mirrors, it is especially suitable for the infrared since it is inherently achromatic and can be cooled to cryogenic temperatures. Potential disadvantages are: (a) that the sampling along the slices is the same as that provided naturally by the telescope meaning there is reduced scope to include a slicer within a spectrograph that must also have a normal long-slit mode and (b) the optical system might be bulky and difficult to fabricate. [4]

4. MUSE简介：

MUSE是multiple units spectroscopy explorer，在希腊神话中muse是代表智慧的女神们，其中图中的Uranis是天文学女神，具体有关情况我们可以看一下视频。

参考文献：

[1] Integral field spectroscopy with the Gemini Multiobject Spectrographs[EB/OL]

[2] 3 spectrography at high spatial resolution. I. Concept and realization of the integral field spectrograph TIGER. [EB/OL]

[3] DensePak and spectral imaging with fiber optics. [EB/OL]

[4] An original image slicer designed for Integral Field Spectroscopy with NIRSpec/JSWT [EB/OL]