Development of an Inexpensive, High-Performance, Easily-Assembled, Low-Dispersion Astronomical Spectrograph

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Two years ago, the astronomy club of the National Institute of Technology Yonago College devised a method for monitoring Earth’s ozone layer through spectroscopic observations during total lunar eclipses. Given the simplicity of this method, we aimed to propose collaborative observations with astronomy clubs across Japanese high schools. However, the lack of spectrographs in most high schools and many Japanese public observatories due to their expense and complexity posed a challenge. Consequently, we undertook the task of developing an affordable and easily assembled spectrograph. The proposed spectrograph features a computer for controlling the rotation angle of the diffraction grating, enabling precise switching between the zeroth- and first-order spectra, which was not possible with other spectrographs. This allows a single camera attached to the spectrograph fulfills dual roles: slit viewing and spectroscopic observation, whereas other spectrographs use two cameras to perform both. Notably, the spectrograph offers low dispersion and captures the visible light spectrum in a single shot, boasting a resolution of R = 1,000 capable of resolving sodium D lines. This resolution is more than 1.5 times higher than the resolution of other spectrographs of the same price as this spectrograph. Moreover, it facilitates the measurement of rotational speeds of galaxies, a capability unavailable with conventional low-dispersion spectrographs. Utilizing readily available components such as telescope connecting rings streamlines fabrication, rendering the spectrograph easy to construct with minimal processing and inexpensive. Already operational at a local public observatory, the spectrograph's designs will soon be made accessible on our college website.