V225c Thermal Modeling of the Focus Position of the NAOJ 188-cm Telescope (II)

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The focus stability of large optical telescopes is of great concern for astronomers. Because components of telescopes are made of materials with different thermal expansion coefficients and thermal inertia, the optimum focal position is inevitably temperature-dependent. Older telescopes have been infamous for their focus variations. One of them is the 188-cm telescope of the former Okayama Astrophysical Observatory which was commissioned in 1960 and employs a solid primary mirror of Pyrex.

We have investigated thermal effects on the focus position of the telescope measured by observers using temperature data of the steel structure and the primary mirror surface in the period from July 2015 to June 2016. Optimum focus positions of the Cassegrain mirror for HIDES-Fiber observations were measured to vary by 5 mm. The mean temperature of the steel structure ($T_{\rm str}$) which supports the primary and secondary mirrors changed roughly between 0 and 30 °C throughout the year. The temperature differences between the front and back surface of the primary mirror ($\delta T_{\rm fb}$) showed variations in the range of -2.7 to $+0.3$ °C. The measured focus positions show strong dependences on both $T_{\rm str}$ and $\delta T_{\rm fb}$. We have found it possible to fit the focus variations with these two parameters with an r.m.s. residual of 0.21 mm. This focus offset causes a blurred optical spot of 0.9 arcseconds. Applying the conductive heat transfer relation, we have calculated the time-dependent temperature distribution inside the primary glass. We are able to improve the accuracy of approximation to 0.12 mm r.m.s., which is close to 0.1 mm, a typical resolution of individual focus determinations by observers.