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ATMOSPHERIC REFRACTION EFFECTS ON LAMOST

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ABSTRACT

Large field spectrographs are severely influenced by atmospheric refraction. LAMOST is a large field multi-object spectroscopy telescope with 5° field of view, f/5 focus ratio and 20m focal length. There will be 4000 fibers simultaneous on it's ϕ1.75m focal plane. Here we discuss the atmospheric refraction effects on LAMOST in two hands. One is the effect of differential refraction across the field, another is the effect of atmospheric dispersion. According to the calculation, we find that: 1. The largest deviation from center within the field is 4.32″during a 1.5-hour integration at 80° declination. 2. The directions of deviation are complex, so the deviations can't be decreased by rotating the field. We also give out the atmospheric dispersions.

Key Words : atmospheric refraction, fiber, large field telescope

I. INTRODUCTION

LAMOST is a Large sky Area Multiple Objects Spectroscopy Telescope which is being prepared by Chinese Astronomy Society. This telescope is a meridian reflecting Schmidt telescope with a 5° view field, 20m focal length and 4m effective aperture. There will be 4000 fibers simultaneous on it's focal plane with 1.75m linear diameter. According to the design of telescope the the largest exposure time is 1.5 hours. This telescope will be mounted in Beijing Astronomical Observatory Xinglong Station with the altitude of about 1000m and the latitude of 40.4N.

Atmospheric refraction affects multiple objects spectroscope in two ways: 1.the effect of differential refraction across the field; 2.the effect of atmospheric dispersion due to the different index of refraction of air. The image of a star is spread out into a line with fixed azimuth. In this paper we will discuss both of the effects.

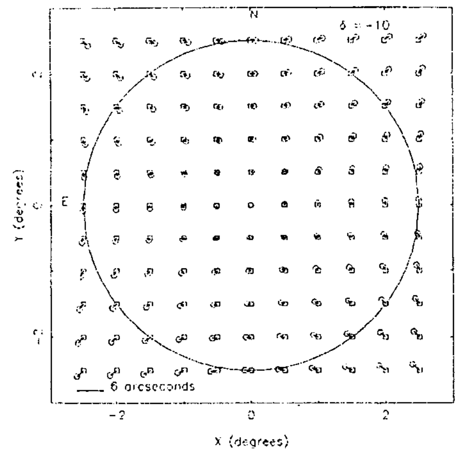

Fig. 1a.

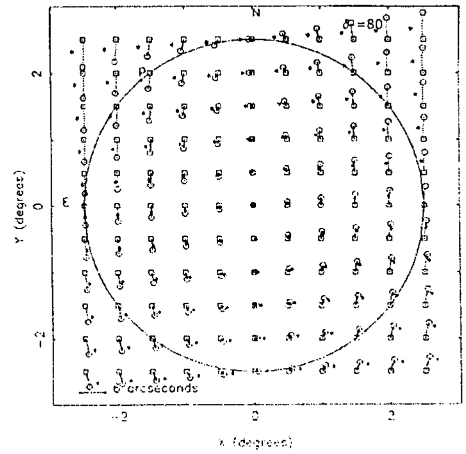

Fig. 1b.

II. DIFFERENTIAL REFRACTION

The differential refraction depends upon z, λ, t_{site} and p_{site}. Here $\lambda = 5000\mathring{A}$. Differential refraction affects the zenith z and parallactic angle q.

$$R(z,\lambda,t,p) = R_0(1 + A' + B')$$

$$= (Atgz + Btg^3 z)(1 + A'(t) + B'(p))$$

The effect of differential refraction on RA. and Dec. direction is:

$$\rho_\alpha = R\sin q \qquad \rho_\delta = R\cos q$$

In Fig.1 We give out this effect across 5°×5° field at declination δ=-10 and δ=80. The effect of refraction is respect to the guiding star. The exposure time is from -0.75 hour to 0.75 hour. The data point interval is 9 minutes. Squares indicate the first data points and circles indicate the last points. The scale of motions is expanded by a factor of 240. The circle makes the edge of 5° field. We notice that in the case of the field with

Table 1. Maxim image motion about center and residual after rotating(arc seconds)

Dec.		-10°	0°	10°	20°	30°	40°	50°	60°	70°	80°
before	5° field	1.46	0.86	0.63	0.56	0.55	0.60	0.73	1.03	1.75	4.32
rotating	3° field	0.86	0.50	0.38	0.34	0.33	0.36	0.44	0.62	1.06	2.62
after	5° field							0.37	0.45	0.83	2.68
rotating	3° field							0.22	0.26	0.43	1.31

$\delta > \phi$ the image motion appears to be approximated by a rotation about the center of the field, the differential refraction effect can be partly decreased by rotating the field about the center. But for the field with $\delta < \phi$, the motion is a radial motion, it can't be decreased by simply rotating the field about center. The * are the positions after rotated an angle which is determined by star P. The largest motions about center and largest residuals after rotating at different declination and different field of view after 1.5 hour exposure is given in Tab. 1.

III. THE EFFECT OF ATMOSPHERIC DISPERSION

The refraction index of air $(n_0(\lambda, p, t, f) - 1)$ is a very strong function of wavelength in the near ultraviolet. The atmospheric differential refraction (arc seconds) relating to λ_0 is calculated for an object at zenith z as:

$$\Delta R(\lambda) = R(\lambda) - R(\lambda_0) = 206265[n(\lambda) - n(\lambda_0)]tgz$$

Fig.2 shows the effect of dispersion of Xinglong Station. Each circle is 350$\AA$ apart. It is normalized to 3800$\AA$. The water vapor pressure is 6mmHg . It is clear that the atmospheric dispersion increases rapidly with increasing zenith.

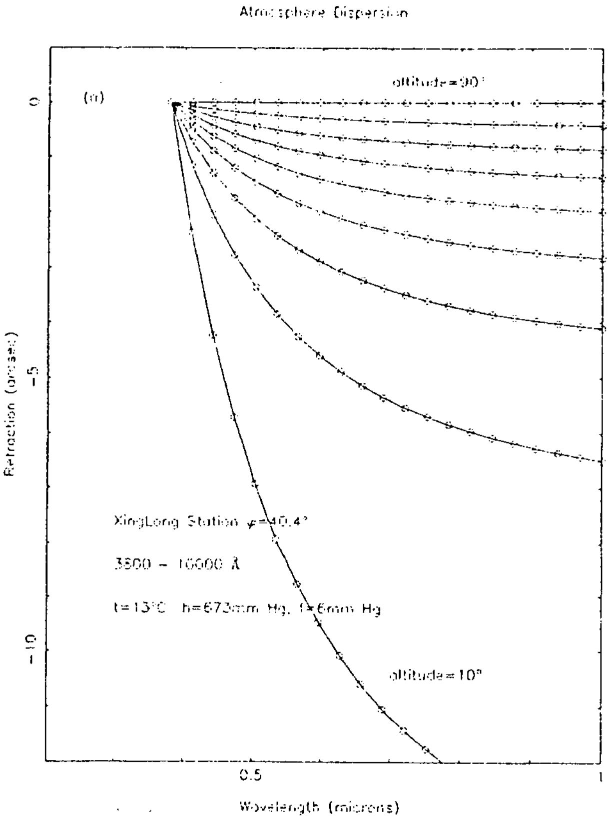

Fig. 2.

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