FAST AND COMPACT WIDE-FIELD GREGORIAN TELESCOPE

Mehdi Bahrami and Alexander V. Goncharov
Applied Optics Group, National University of Ireland, Galway

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Introduction

A traditional Gregorian telescope features an intermediate focus, which makes the system longer than an equivalent f-number Cassegrain design [1]. One could shorten the Gregorian system by inserting a flat mirror before the secondary mirror. A 0.5 m f/1.4 telescope with 4 deg full field is presented. The modified design consists of two elliptical mirrors and a folding flat in between. A plano-convex field flattener is used near the focal plane.

Telescope design

Figure 1 (a) show the Aplanatic Gregorian design with a field flattener and the linear central obscuration of 72% (50% in area) due to the oversized elliptical secondary mirror. One could use a folded design shown in Fig. 1(b) to maintain the power of the primary and provide an acceptable central obscuration. The folded design has only 45% linear obscuration (20% in area), while delivering the same performance as the original system in Fig. 1 (a).

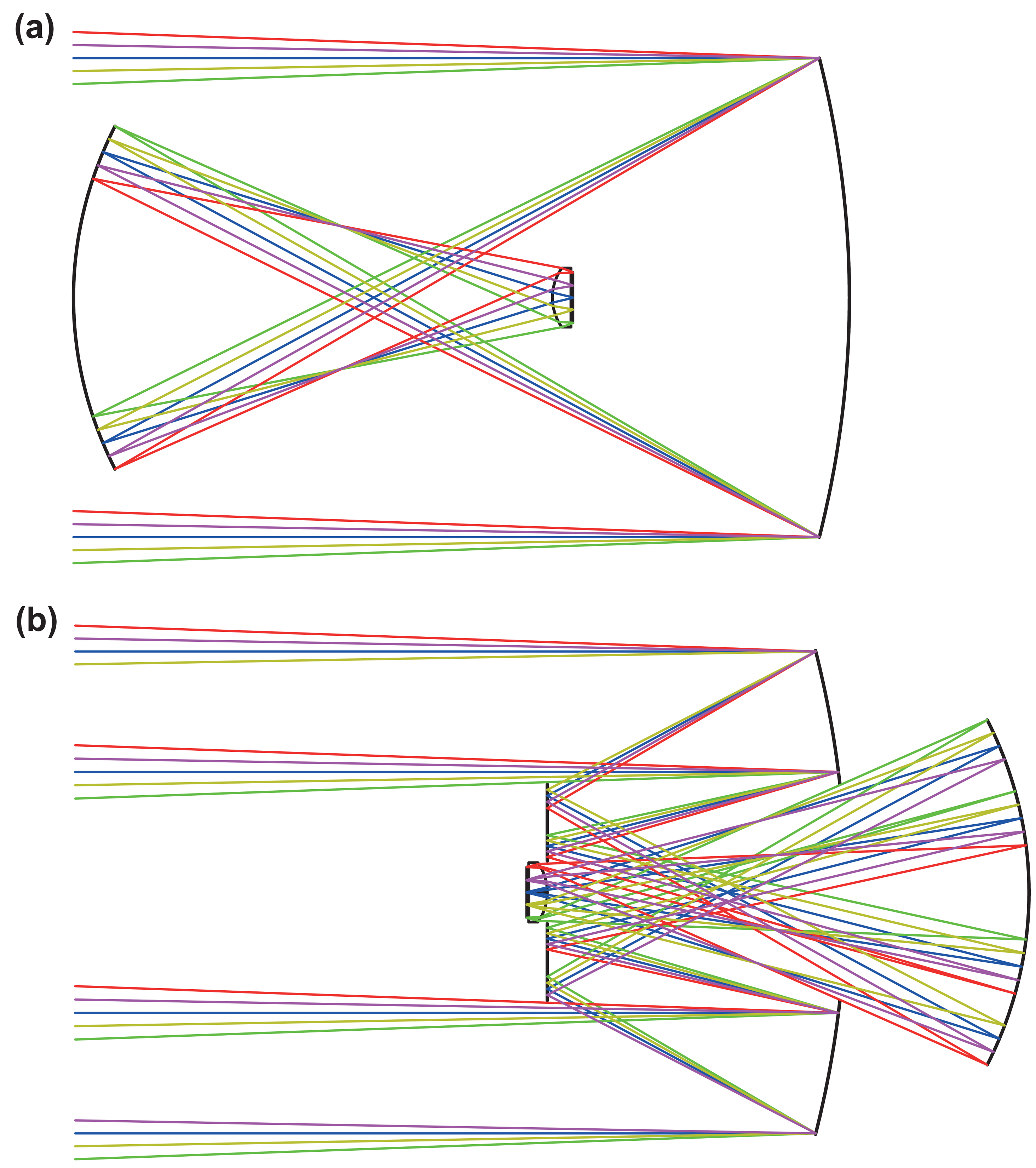

Fig. 1.The optical layout of an f/1.4 Gregorian telescope (a) and the f/1.4 folded design (b).

Table 1. Optical parameters of the f/1.4 folded Gregorian design (units are mm).

#	Radius	Thickness	Glass	Semi-Diameter	Conic
1	-1000.000000	-310.000000	MIRROR	250	-0.786227
2	Infinity	500.000000	MIRROR	113	0.000000
3	-387.597652	-500.000000	MIRROR	179	-0.146604
4	-53.193366	-19.304078	N-BK7	31	0.000000
5	Infinity	-2.000000		27	0.000000
Image	Infinity	0.000000		25	0.000000

The spots are well-matched for two-pixel sampling per spot radius using a detector with 10 micron pixels. The angular resolution is limited by the pixel size of the detector.

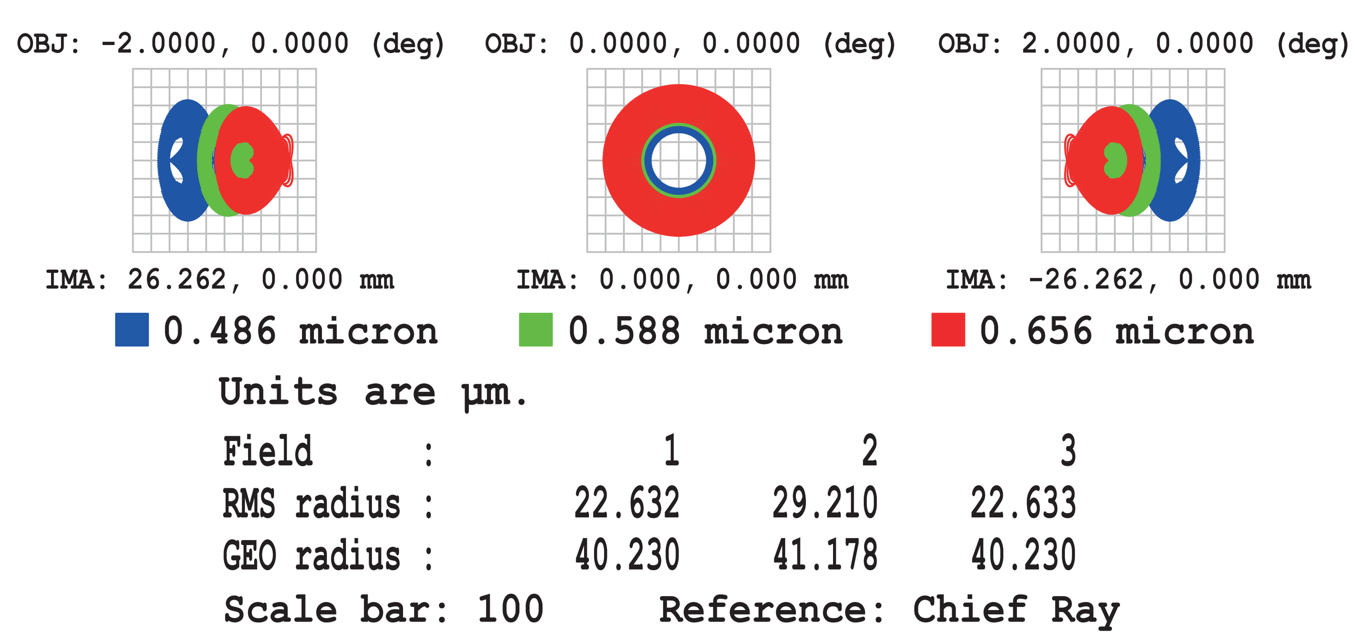

Fig. 2. Spot diagrams for the f/1.4 folded Gregorian design.

Balancing aberrations

Figure 3 shows the third-order aberrations of each optical component in the telescope system. The field flattener compensates astigmatism and field curvature of the primary and secondary mirrors. The field flattener introduces large amount of pincushion distortion (5%), which should not present a problem, since the images can be corrected by image post-processing. The elliptical primary and secondary mirrors compensate spherical aberration and coma.

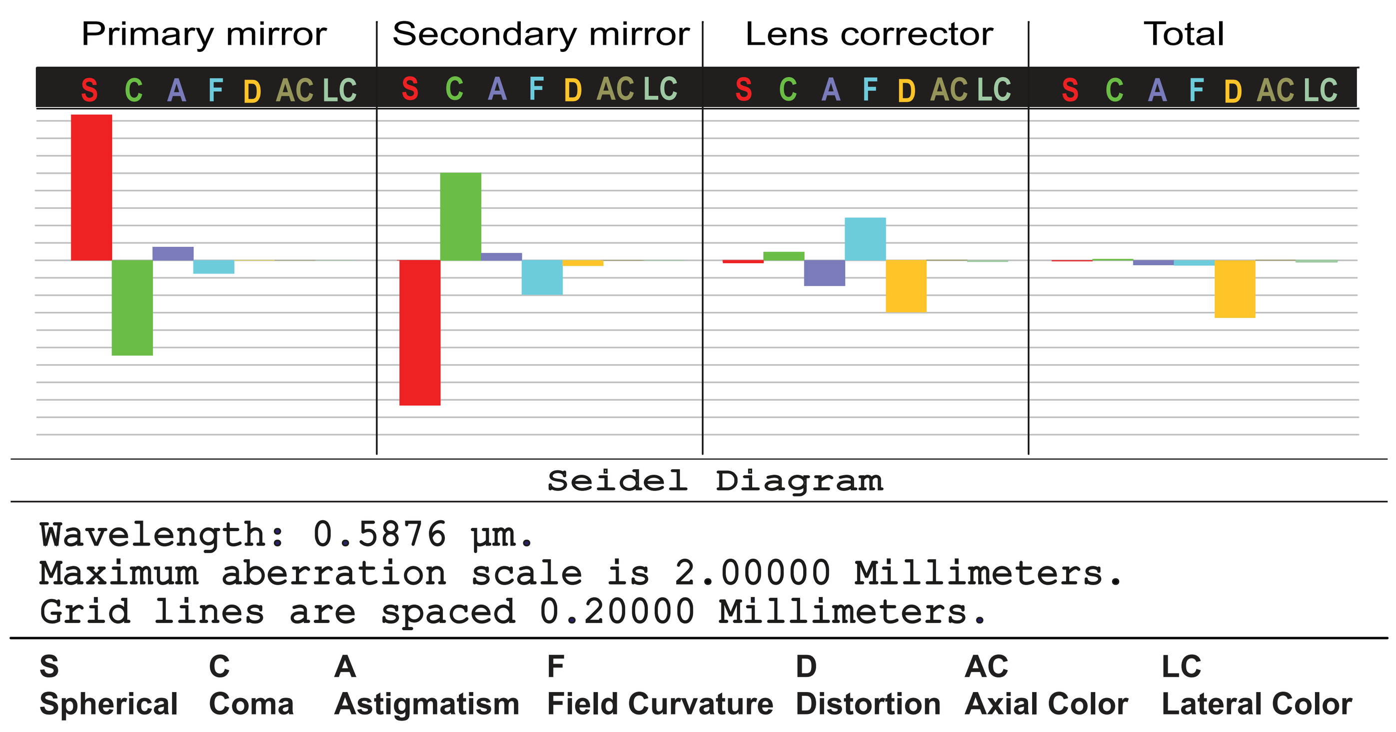

Fig. 3. Aberration compensation in the f/1.4 folded Gregorian design.

Stray light

Stray light in telescope systems is usually a challenging problem, which requires special considerations [2]. Figure 4 shows the incoming stray light and the baffles designed to reduce it. The intensity of the residual stray light is approximately 460000 times lower than the intensity of the well-focused image spots. The required length of the external and internal baffles attached to the primary mirror are 587 mm and 207 mm, respectively as can be seen in Fig. 4(b). The overall length of the telescope does not exceed 1 m.

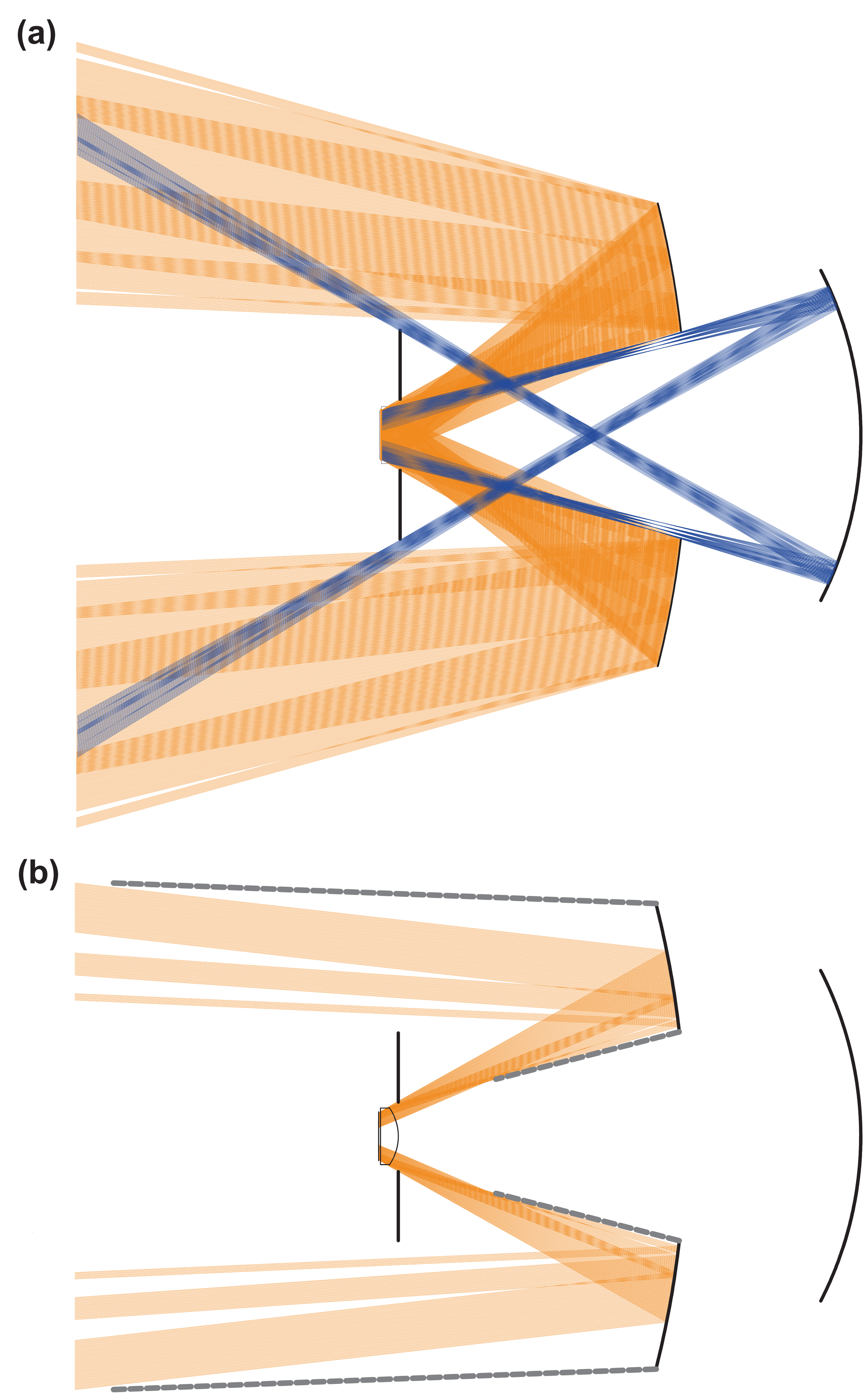

Fig. 4. Stray light from the field of 28.5 deg to 31.5 deg reflected from the secondary mirror, and 2.5 deg to 15.5 deg reflected from the primary (a), the residual stray light after adding two 590 mm and 210 mm baffles- with the residual stray light from 2.5 to 6.5 deg fileds (b).

References

[1] Rutten, H. and van Venrooji, M., *Telescope optics*, (2002).
[2] Wilson, R. N., *Reflecting Telescope Optics I*, (2007).