4.4: Coma

Coma, like astigmatism, is another aberration that appears off axis, near the edge of an image field. If you look at a wide-field photograph of some stars taken with a photographic telescope, the stars near the centre of the field should be points, but, at the very edge of the photograph, if the telescope is less than perfect, the stars may appear like little comets, with a sharp nucleus, but each with a fuzzy tail directed away from the centre of the photograph. This aberration is called “coma”. The word “coma”, as well as the word “comet”, comes from the Latin *coma*, meaning “hair”, from a fanciful resemblance of a comet, or of a comatic image of a star, to the head of a girl with her long hair streaming out behind her.

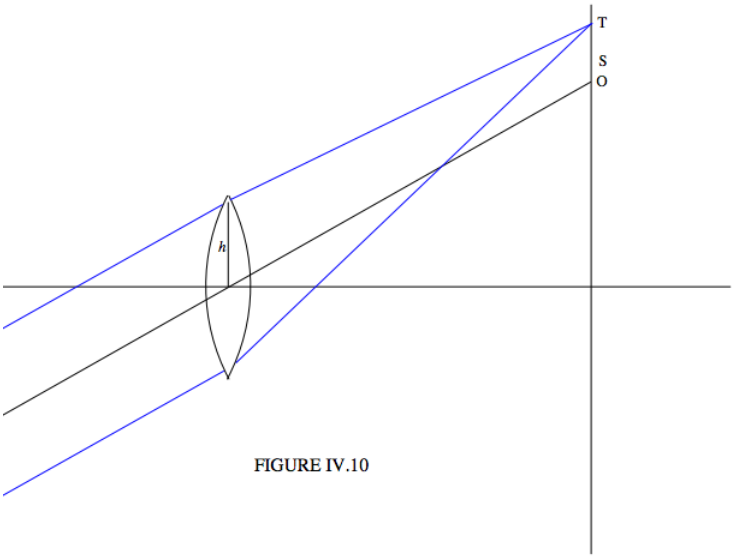


FIGURE IV.10

In Figure IV.10, we see a parallel bunch of rays entering the lens obliquely from the left. The central ray, in black, goes straight through to a point O. Two rays in the tangential plane (i.e. the plane of the computer screen, or the paper, if you have printed it out) converge not to the point O, however, but to a point T as shown. If I could draw two rays equally far from the centre of the lens but in the sagittal plane (i.e. a vertical plane perpendicular to the plane of the paper), they would converge to a point S, about a third of the way between O and T.

If I could draw the rays entering the lens all around the zone of radius h on the lens, each pair of opposite rays would converge to a point on the *comatic circle*. See Figure IV.11.

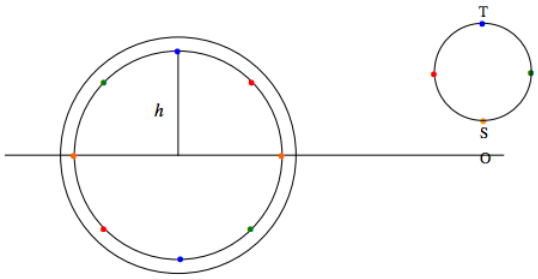
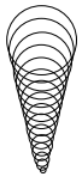


FIGURE IV.11

The radius and height of the comatic circle is different for each zone on the lens that produces it, with the result that the “image” appears as a superposition of all the comatic circles produced by all the zones on the lens, something like the drawing below. That, at least is a qualitative description of the phenomenon.



To go further is a bit of a specialist skill, so I'll leave it here. Suffice to say that the degree of coma and the degree of spherical aberration depend on the shape factor of the lens, and fortunately the shape that gives least spherical aberration is not very different from the shape that gives least coma.

The aberrations discussed so far are aberrations that result when the lens or mirror does not produce a point image of a point object. If, somehow, we manage to get rid of spherical aberration, astigmatism and coma, then a point object will result in a point image. But will that image be in the right place? There are two further aberrations that are concerned with where the image is formed. These aberrations are *curvature of field* and *distortion*.
