Re: spherical mirrors matching the curve of parabolic

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- *From*: "nick" <vladis.2@xxxxxxxx>
- *Date*: 28 Apr 2005 18:38:57 −0700

jtaylor wrote:

>
> What I don't know is how far from the centre you could put a
spherical
> mirror of some specified dimension before the error would be above
> acceptable limits.
>

If you consider a pair of mirrors focusing at the same point,
it is a multiple aperture telescope, and the mirrors are
segments of an imaginary larger mirror. It makes quite a
bit of difference if this larger mirror is a sphere, vs.
parabola. A parabola has zero spherical aberration, and
any off−axis segment, no matter how far from the axis has
also zero spherical aberration; the only aberrations are
segmentary coma and astigmatism, which are roughly 2−3 times
smaller than those of the larger imaginary mirror (whose
diameter/F# are determined by the diameter, f.l. and off−axis
distance of the two mirrors).

But off−axis segments of a sphere are different story. For instance,
a pair of 3" f/10 spheres nearly touching would be a part of an
imaginary 6" f/5 sphere. This sphere has more than 1 wave p−v of
spherical aberration (from w=22.6D/F^3, for D in inches and 550nm
wavelength). Either off−axis segment would have significantly less
of s.a. (nearly 1/15 wave), but the large s.a. of the larger
imaginary mirror metamorphosically change into significant
astigmatism and coma. The segments act as tilted spheres; the angle of
tilt (t) in this case is given by 1/8F (F being the F# of larger
imaginary mirror) or 1.43 degrees. Resulting astigmatism − in terms of
comparable
amount of spherical aberration (same RMS wavefront error) − is 1/1.36
wave
p−v (from w=1.2Dt^2/F, for D in inches, "t" in degrees, and F the F# of
a tilted concave mirror). This is the amount for each segment
separately; in the merged image, it would be higher due to the width of

diffraction pattern being approx. twice smaller in the plane determined by the centers of the two mirrors (the image plane would also be tilted in regard to the optical axis).

In short, a pair of spherical mirrors wouldn't work well in such an arrangement, unless very small or very slow. A pair of parabolic mirrors
wouldn't have spherical aberration, but would also act as tilted (since not an off−axis parabola segment) and produce identical amount of astigmatism
and coma as a spherical pair. Any tilt would result in astigmatism; a pair
of 3" f/10 mirrors tilted upward just enough to place flats out of incoming
light, would need at least 2−degree mirror tilt, which would result in the amount of astigmatism comparable to 1.44 waves p−v of spherical aberration.

Vlad

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- ***References***:
  - ***spherical mirrors matching the curve of parabolic***
    - ◊ *From:* jtaylor
  - ***Re: spherical mirrors matching the curve of parabolic***
    - ◊ *From:* dkelvey
  - ***Re: spherical mirrors matching the curve of parabolic***
    - ◊ *From:* jtaylor

- Prev by Date: ***Re: John Edwards=John Edmund=John Patterson=John Jacobson=John Shuttlebower=Ryan Walters???***
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