Multiple Mirror Telescope Observatory

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MMT TECHNICAL MEMORANDUM 87-2

FROM: D. R. Blanco

RE: 6.5 m upgrade engineering calculations

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I thought I'd collect together a few equations that are useful for estimating basic parameters of large telescopes built with honeycomb mirrors. The reference for many of these is a paper by W. Wetherell, "The Use of Image Quality Criteria in Defining a Diffraction-Limited Large Space Telescope," *S.P.I.E.*, Vol. 28, March 1972. Figure 1 shows the standard Cassegrain layout.

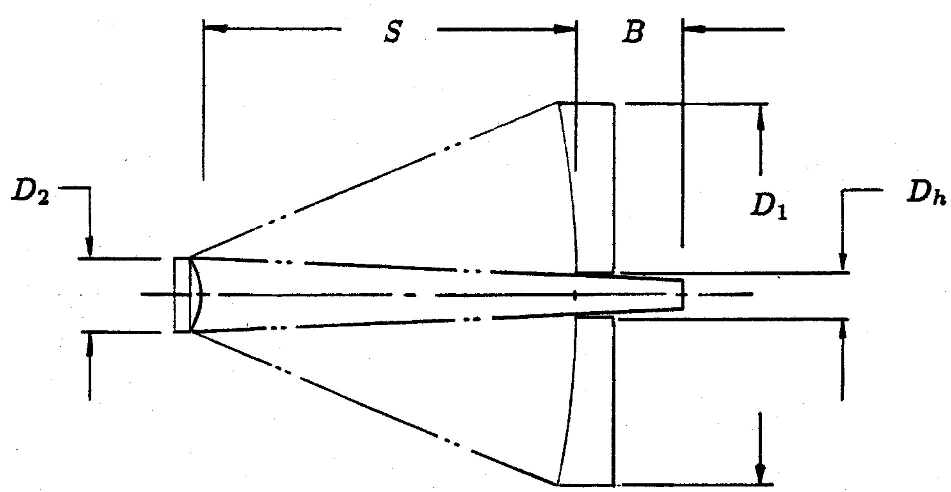

Figure 1. Standard Cassegrain configuration.

I. Primary Volume and Weight

The volume of the primary is given by:

$$V = \frac{\pi D_1{}^3}{4AR} - \frac{\pi D_h{}^3}{4}\left\{\frac{1}{2\sqrt{2}} + \frac{D_1}{D_h}\left(\frac{1}{AR} - \frac{1}{32F_1}\right)\right\}, \tag{1}$$

where:
D_1 is the primary mirror diameter,
AR is the mirror aspect ratio,
D_h is the Cassegrain hole diameter, and
F_1 is the primary mirror focal ratio.

The weight of a honeycomb mirror is approximately 20.8% of the solid weight; pyrex glass has a density of 0.081 pounds per cubic inch.

One note: the aspect ratio is taken as the ratio of the *average* thickness to the diameter. The average thickness for a paraboloid occurs at a diameter equal to $D_1/2\sqrt{2}$, and is $D_1/32F_1$ less than the edge thickness.

II. Cassegrain Hole Diameter

The *minimum* hole diameter for a given field size θ (in radians) is:

$$D_h = D_1\left\{\frac{\eta(F_1+\eta) + \theta F_1(F_2{}^2 - \eta^2)}{F_2(F_1+\eta)}\right\}, \tag{2}$$

where:
η is the normalized back focal distance (B/D_1 in figure 1),
F_2 is the Cassegrain focal ratio.

III. Secondary Diameter

The secondary diameter is given by:

$$D_2 = D_1\left\{\frac{F_1 + \eta + \theta F_1(F_2 - \eta)}{F_1 + F_2}\right\}. \tag{3}$$

IV. Secondary Volume and Weight

The secondary volume is:

$$V_2 = \frac{\pi D_2{}^3}{4AR}, \tag{4}$$

where: AR is now the secondary aspect ratio.

Once the volume is found the weight can be calculated in the same way as the primary weight.

V. Mirror Spacing

The distance from the primary vertex to the secondary vertex is:

$$S = D_1 \frac{F_2 - \eta}{m + 1}, \tag{5}$$

where: m is the Cassegrain magnification (F_2/F_1).