DESIGNS OF DISTORTION-FREE APLANATS

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It is characteristic of distortion-free aplanats with a concave primary and a convex secondary mirror that the position of the focal surface is determined giving one of the parameters of the construction and imposing the equation

$$\sum_{i=0}^{i=7} a_i q^i = 0$$

which can be also expressed as a function of ξ, being q the minimum obstruction -without field- of the secondary mirror given as a fraction of the diameter of the primary mirror and ξ the ratio between the focal lengths of the secondary and primary mirrors.(1) In practice it is convenient to express the position of the focal surface as a function of q; which leads us to consider two possibilities:

1° - A large obstruction $q > 0{,}42$, which locates the focal surface behind the vertex of the primary mirror.

2° - A moderate obstruction $q < 0{,}42$, which locates the focal surface between the primary and the secondary mirror.

The first case is feasible when building telescopes with a primary mirror under 2,50 meters and the second case for telescopes with a primary mirror of a larger diameter. In both cases the instruments should be compact and the dome should have a smaller diameter.

An additional problem in all Cassegrains is that direct light from the sky should not fall on the focal plane; a solution has been sought by means of three stops named exterior, secondary and focal stops.Their functioning and situation is shown in fig.1. They can be calculated without major difficulties deducing the necessary formulas geometrically.The following paragraph indicates the procedure and give some examples.

First the focal ratio, the obstruction without a field q, the magnification and the useful field to be given to the telescope are fixed, As the diameter of the field in which the stellar image is kept to $\lesssim 1''$ in most cases is from 30' to 40', it is convenient to fix the size of the field and leaves it constant for the different oases which are calculated, as the photographic plate will not be out exactly to the diameter of the theoretical field. In practice this field can be considered to be 40'. With the parameters shown above, the separation of the mirrors and the position of the focal surface can be easily obtained(2). It is also convenient to oalculate the diameter of the secondary taking into account the actual field.

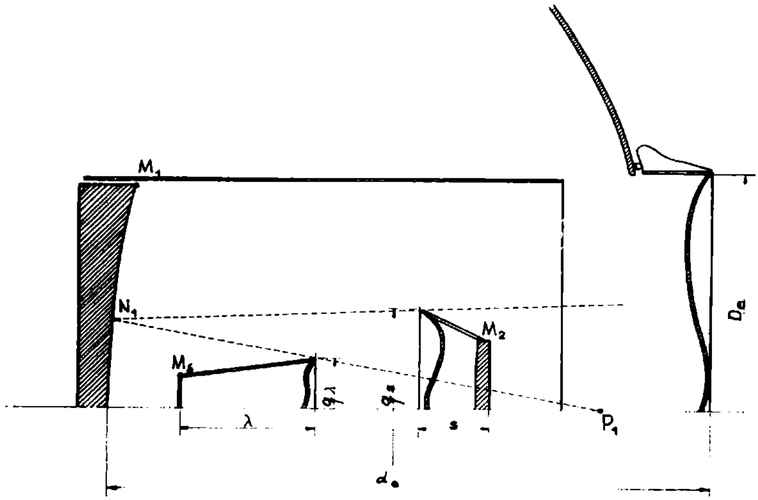

Fig. 1

It is convenient to calculate first the secondary stop which is located over the edge of the cell containing the secondary mirror; its form is truncated cone and its inclination with respect to the optical axis is determined by the equation of the ray which unites the edge of the primary mirror M_1 with the edge of the secondary mirror M_2 (diameter calculated with field). We denominate q_s the maximum diameter of this stop and s its length projected on the optical axis.

The second stop is located over the focal surface. Its diameter and major length are determined by the intersection of the ray M_1P_1 (this ray corresponds to the reflexion in the primary mirror of the one grazing over the edge of the secondary stop with an incidence angle equal to half the angle corresponding to the field) with M_2M_δ (this ray joins the edge of the secondary mirror with the edge of the field). We denominate q_λ its major diameter and λ its lenth. Evidently, this stop does not have to be a truncated cone as indicated in the figure, it can be substituted by conveniently placed discontinous rings.

The exterior stop is obviously determined by the straight line which unites the edge of the focal stop with the edge of the secondary stop; this straight line is extended as far as the intersection of the telescope tube, or the ray incident on the primary mirror, the corresponding maximum field being taking into account.

Examples:

Two widely separated examples are given, one with a large obstruction and another with a small one. It must be remembered that the sides of the stops also depend on the total luminosity of the telescope.

f	5,2	6,0	(focal ratio of the system)
ξ	2,0	0,5	
q_o	0,483	0,280	(diameter of secondary with field)
d	2,18	2,19	(distance between vertices of the mirrors)
θ	37'1	29'1	(diameter of field in which the image is kept equal or inferior to 1")
q_s	0,50	0,40	
s	0,07	0,36	
q_λ	0,28	0,18	
λ	1,52	0,78	
D_e	1,07	1,05	(diameter of exterior stop).
d_e	3,78	2,97	(distance between vertex of principal mirror and outer edge of exterior stop).

Except when specially indicated, the values of the examples are non dimensional or have $D_1 = 1$ (D_1 = diameter of principal mirror).

The diameter of the necessary dome is always smaller than the quantity d_e; it can even become a small fraction of this quantity taking into account that the principal mirror is under the revolving centre of the dome and that the exterior stop can be made sufficiently large. At first approximation the radius of the dome is obtained by means of the following equation:

$$r = d_e - 1,3 \qquad (D_1 = 1)$$

If we consider in the second example that D_1 = 6 meters, the value of the radius of the dome would be only 10 meters.

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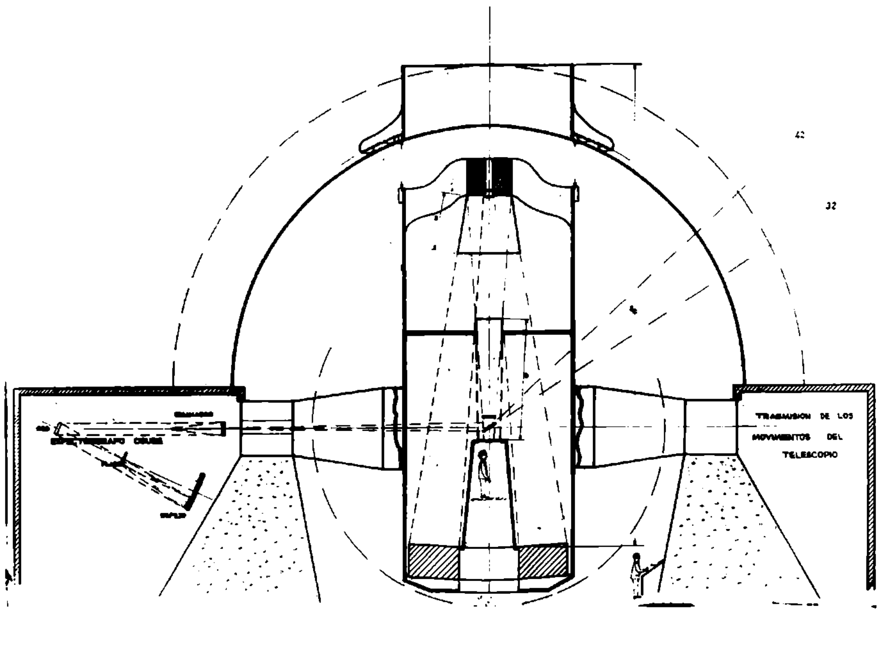

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