Aberrations on a concave mirror (catacaustics)

Principle and equipment

Principle

Demonstrate that aberrations exist on a concave mirror if the light beams are not close to the axis.

Equipment

Position No.	Material	Order No.	Quantity
1	Demo Physics board with stand	02150-00	1
2	PHYWE Multitap transformer, DC: 2/4/6/8/10/12 V, 5 A / AC: 2/4/6/8/10/12/14 V, 5 A	13533-93	1
3	Lamp,halogen,mag.held,12V/50W	08270-20	1
4	Concave/convex mirror,magnet held	08270-12	1
5	Diaphragm w. holder, magnet held	08270-10	2
Additonal material:			
	Ruler		
	Circular template (see master) or a drawing compass		
	Water-soluble white board pen		

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Set-up and procedure

- Draw the optical axis.
- Using the circular template or a drawing compass, draw a circle with radius r = 200 mm on the magnet optics board.
- Place the mirror on the circular arc.
- Place the magnet-held lamp with a three-slit diaphragm so that the middle light beam travels along the optical axis. If necessary, readjust the mirror. Label the focal point (Fig. 1).
- Replace the three- slit diaphragm with a five-slit one, and by using diaphragms with holders to alternately block the two parallel beams close to or far from the axis and to let the others strike the mirror (Fig. 2 shows the path of the beams far from the axis.).
- Move the magnet-held lamp up and down so that the parallel rays partly strike the mirror very far from the axis. Observe the reflected beams and if necessary, trace the paths of a few of them (Fig. 3).
- Remove the mirror and the lamps and complete the light paths.

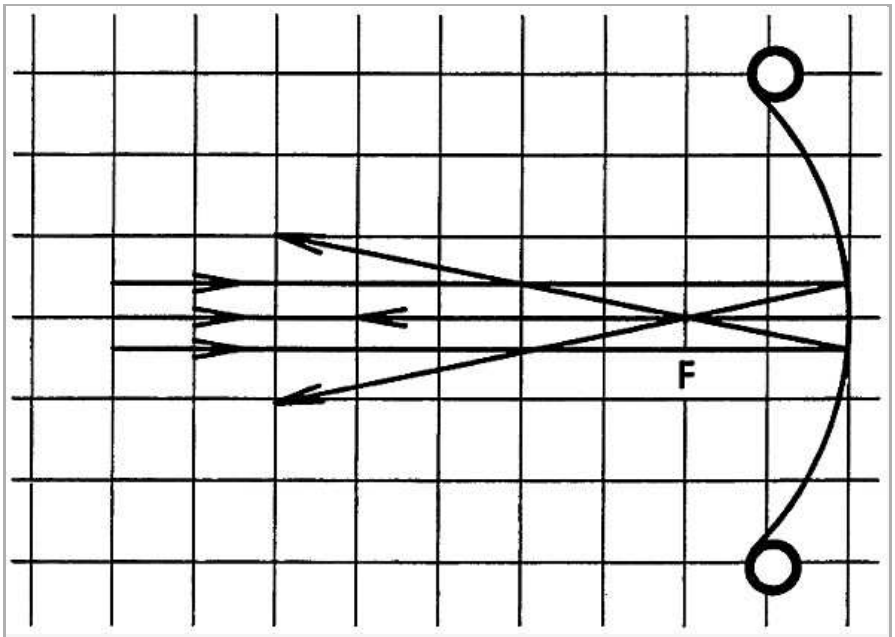

Fig. 1

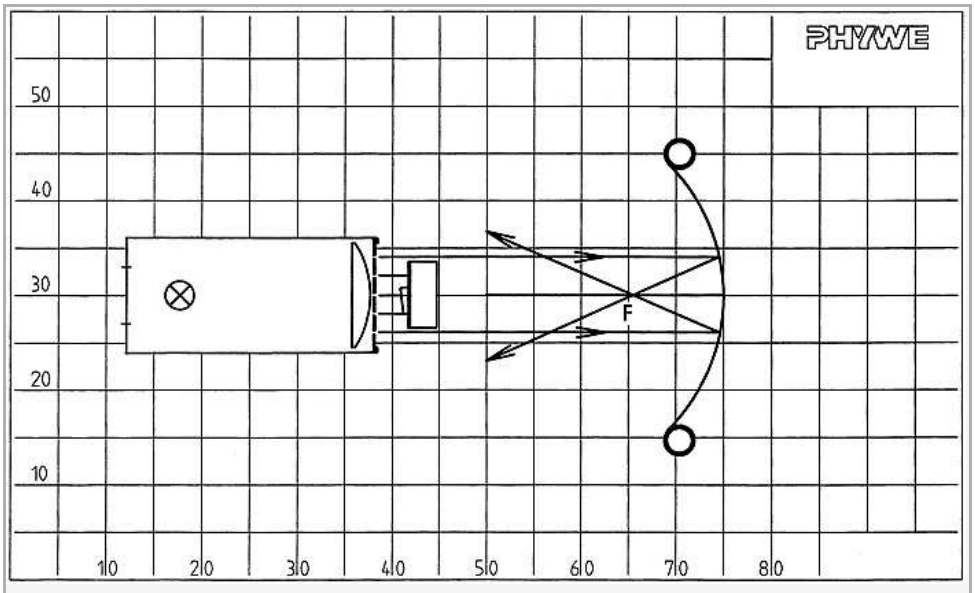

Fig. 2

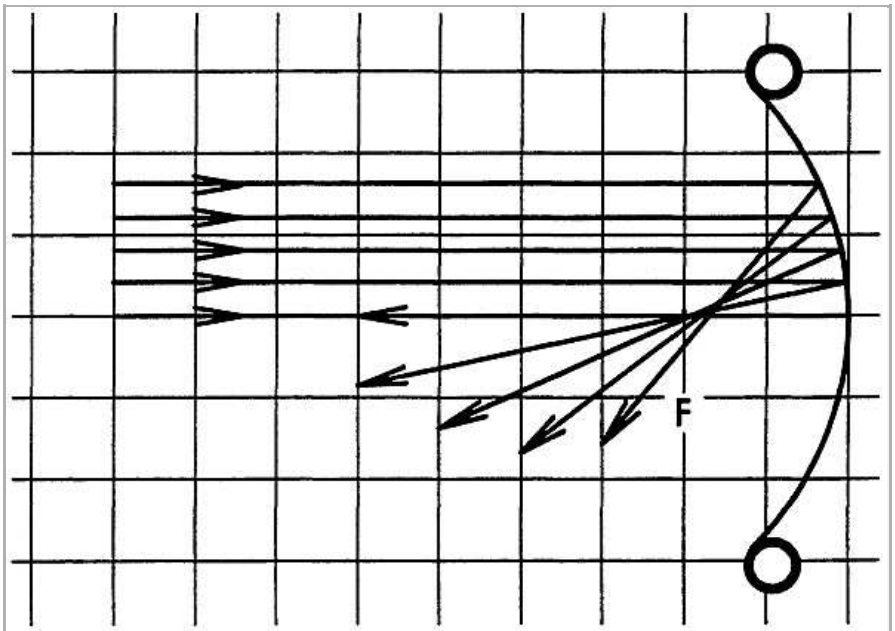

Fig. 3

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Observation and evaluation

Observation

Only parallel beams which are sufficiently close to the axis are reflected in such a way that the intersect at one point on the optical axis, the focal point, of a concave mirror. After reflection, parallel rays which are far away from the axis travel so that the further they are away from the optical axis, the closer to the mirror's vertex they intersect the optical axis.

Evaluation

Images on concave mirrors become unfocused or distorted if the object is relatively large compared to the mirror's radius of curvature. This is due to the fact that rays parallel to the axis are partly rays which are far from the axis.

Remark
If the term catacaustics is to be treated, the one can sketch the diacaustic curve for the reflected rays.
This diacaustic curve can be even more elegantly generated, if the magnet-held lamp is last used without a diaphragm and the wide parallel light beam is move up and down parallel to the optical axis.
To make a circular template the master copy (see Fig. 1 in the Foreword) can be copied, pasted on thin cardboard and cut to size.

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