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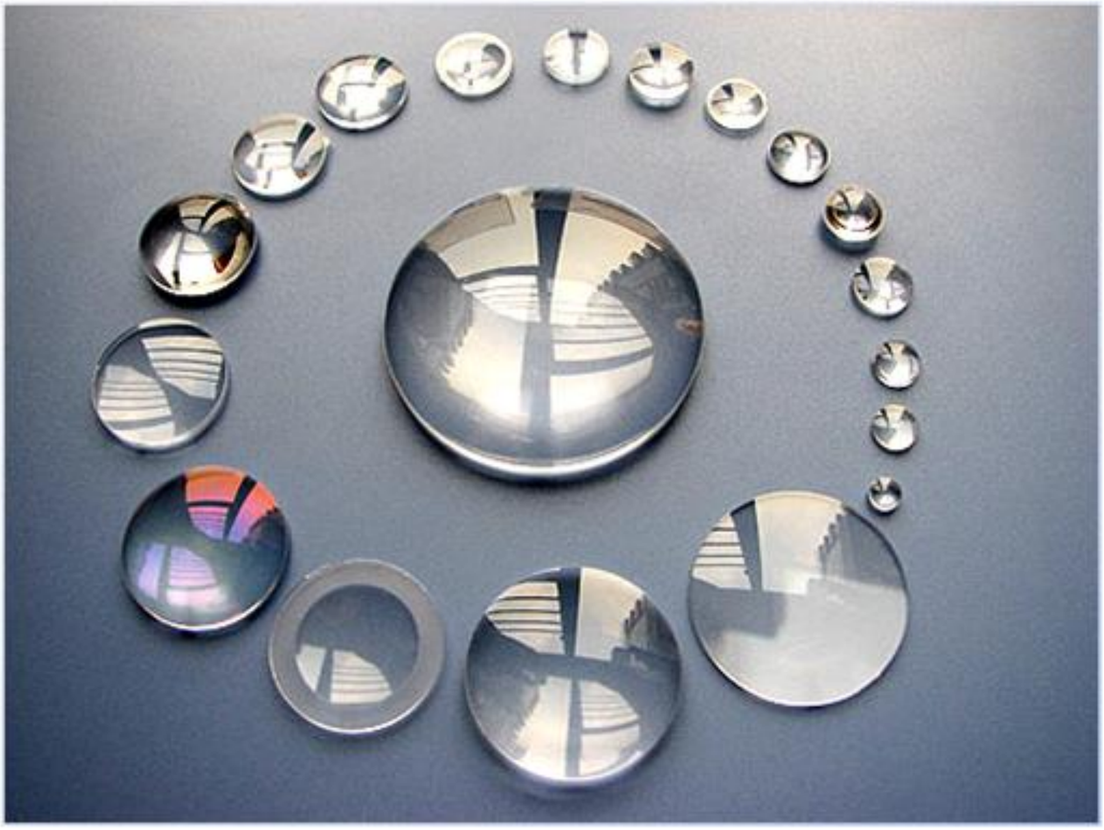
Fence-Posts Light Transmission Problem



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Introduction

It is beyond our understanding how scientists can make inference from the light from far galaxies. But it is a very common experience when we walk passed some fence-posts on the roadside, we can feel the change in brightness with different angles of view. What messages can be obtained by noting the change in the light passing through the mesh of fence-posts?

The posts are usually separated uniformly at an equal distance and they may have unknown shapes. The fraction of light passing through the mesh of posts depends on the gap separation and is also related to the shape of the post.

In this project, we want to investigate how the shape and orientation of some fence-posts will affect the fraction of light passing through the mesh. We will investigate on fence-posts with rectangular, circular or triangular shapes. After finding out the expressions for the fraction of light transmitted, we could apply graphing calculator from the internet to compare the results for different shapes or orientations. With further use of computer programs, we can also obtain the optimal values of the fraction of light passing through meshes of square or triangular fence-posts.

Ch 5 Conclusion

From Chapter 1, we investigate the simple cases of fraction of light passing through common rectangular or circular fence-posts. The functions of the fraction of light transmitted F_θ for them are very different. We can even infer the shapes of the fence-posts by simple observation of the amount of light passing through.

From Chapter 2, we focused on fence-posts with shapes of square or equilateral triangle with constant gap separation. By comparing two basic orientations for each of the shapes by Desmos graphing calculator, we find that the meshes with these orientations will seem brighter or darker for different ranges of values of viewing angle.

From Chapter 3 and Chapter 4, we consider the cases for different orientations of fence-posts with shapes of square or equilateral triangle. Two different assumptions – one with constant gap separation and one with constant fence-post separation are made for these two chapters respectively. For basic orientations, results similar to those of Chapter 2 are obtained.

With the help of Wolfram Alpha Widgets: Area under a curve calculator, we can obtain the corresponding optimal value of the fraction of light transmitted through the mesh of square or triangular fence-posts. The following table will summarize the findings under these two assumptions:

	Constant Gap Separation(=2)	Constant Fencepost Separation(=4)
Square posts	Greatest average F_θ = 0.380993378 (b = 45°) Least average F_θ = 0.299121529 (b = 0 °)	Greatest average F_θ = 0.437607975 (b = 45°) Least average F_θ = 0.413141404 (b = 0°)
Triangular posts	Greatest average F_θ = 0.422058537 (b = 30°) Least average F_θ = 0.415176741 (b = 60°)	Greatest average F_θ = 0.529402944 (b = 60°) Least average F_θ = 0.521448889 (b = 30°)

From the above table, we found that the square posts with a vertex on the base line (b = 45^o) would on average allow more light passing through than that with a side on the base line (b = 0^o). This result may be applied to both the constant gap and constant fencepost separations. But for equilateral triangular posts, two different results arise:
For constant gap separation, the triangular posts with a side on the base line (b = 30^o) would on average allow more light passing through than that with a vertex on the base line (b = 60^o).
For constant fence-post separation, the triangular posts with a vertex on the base line (b = 60^o) would on average allow more light passing through than that with a side on the base line (b = 30^o).

Reference:

A Mathematical Nature Walk by John A. Adam Princeton
(P.43-P.48)