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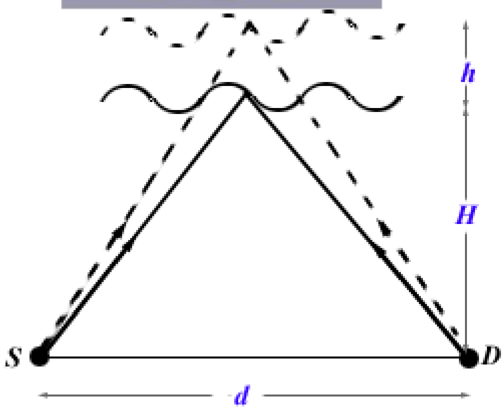
<u>Problem 19.37 (RHK)</u>

A source S and a detector D of high-frequency waves are a distance d apart on the ground. The direct wave from S is found to be in phase at D with the wave from S that is reflected from a horizontal layer at an altitude H. The incident reflected rays make the same angle with the reflecting layer. When the layer rises a distance h, no signal is detected at D. We have to find the relation between d, h, H, and the wavelength λ of the waves. We can neglect absorption in the atmosphere.



<u>Solution:</u>

The distance between the source *S* and detector *D* of high frequency waves is *d*. Let us consider the situation when the direct wave from *S* to *D* is in phase with wave from *S* that reaches D on reflection from a horizontal layer at an altitude H. This situation requires that the path difference between the direct ray and the reflected ray be an integral multiple of wavelength λ. That is

$$2\sqrt{\left(\frac{d}{2}\right)^2 + H^2} - d = n\lambda,$$

where n is some integer.

According to the problem, no signal is detected at D when the reflecting layer rises a distance h. This implies that now the path difference would have increased by $\lambda/2$. That is

$$2\sqrt{\left(\frac{d}{2}\right)^2 + (H+h)^2} - d = \left(n + \tfrac{1}{2}\right)\lambda.$$

Using the result that

$$n\lambda = 2\sqrt{\left(\frac{d}{2}\right)^2 + H^2} - d,$$

we get

$$\sqrt{d^2 + 4(H+h)^2} = \sqrt{d^2 + 4H^2} + \frac{\lambda}{2},$$

or

$$\lambda = 2\left(\sqrt{d^2 + 4(H+h)^2} - \sqrt{d^2 + 4H^2}\right).$$