MASSACHUSETTS INSTITUTE OF TECHNOLOGY

2.71 Optics **Spring '09**

Problem Set #5 Posted Monday, March 30, 2009 — Due Wednesday, April 8, 2009

1. Two plane waves of the same wavelength λ are propagating along the directions of wave vectors $\mathbf{k}_1, \mathbf{k}_2$ as shown in the figure below.

1.a) Describe the interference pattern that would be observed on the plane xy.

1.b) Describe the interference pattern that would be observed on a plane parallel to xy but one wavelength λ away towards the positive z direction.

1.c) Describe the interference pattern that would be observed on the plane yz.

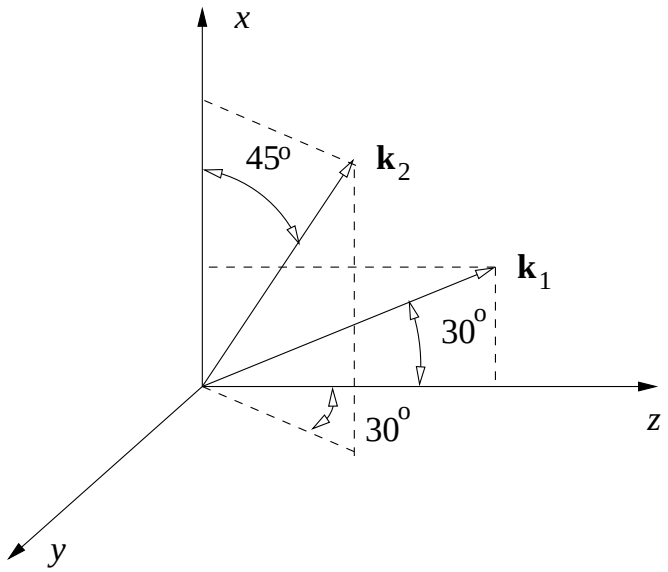

Figure A

2. A plane wave and a spherical wave, both of the same wavelength, are co-propagating as shown in figure B on the next page.

2.a) Describe the interference pattern that would be observed on a plane perpendicular to the z axis at a distance of 1000λ away from the origin of the spherical wave.

2.b) Repeat for the plane located 2000λ away from the origin of the spherical wave.

2.c) What do you observe? Explain in physical terms.

2.d) What is the relationship between your result and a Michelson interferometer with a lens inserted in one of the two arms?

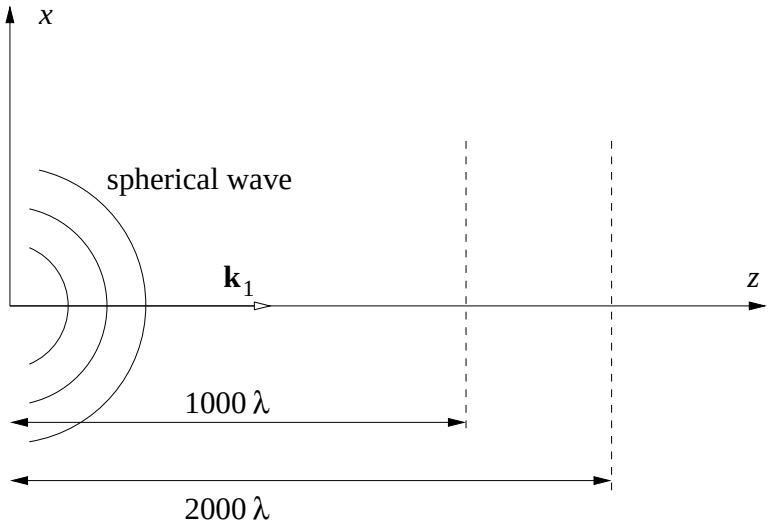

Figure B

3. Repeat the calculations of the previous problem for the case when the plane wave is propagating off-axis as shown in Figure C below. Explain the differences that you observe.

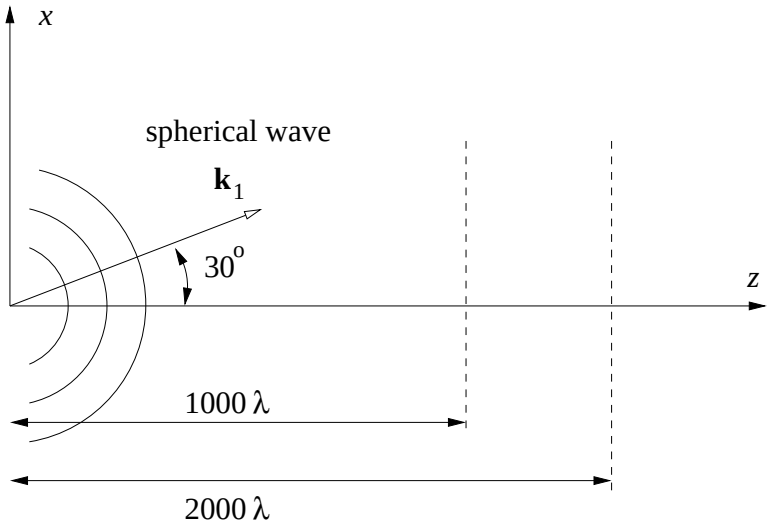

Figure C

4. A "fan" of N plane waves are propagating symmetrically with respect to the z axis, as shown in figure D below. The angular spacing between successive members of the fan is fixed and equal to $\Delta\theta$. Describe the interference pattern observed on a plane perpendicular to the z axis.

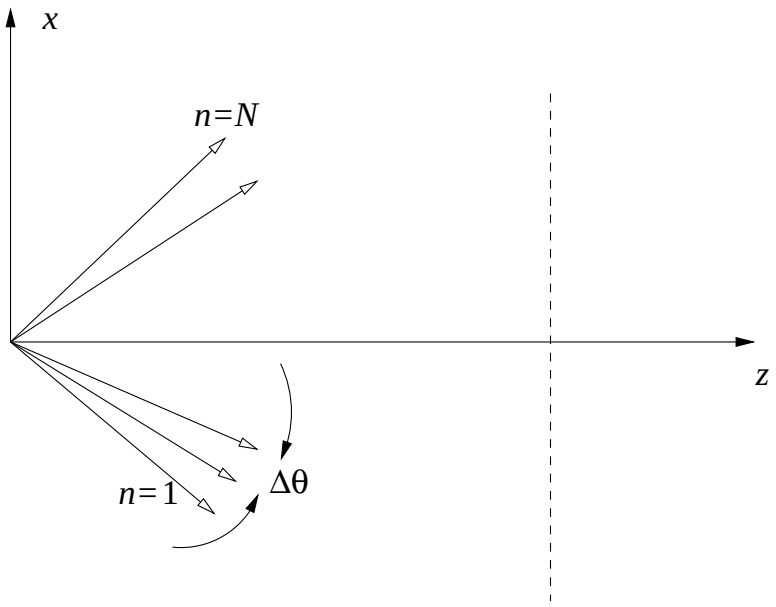

Figure D

5. Describe the interference pattern between two counter-propagating plane waves. This is also known as a "standing wave." Explain why.

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