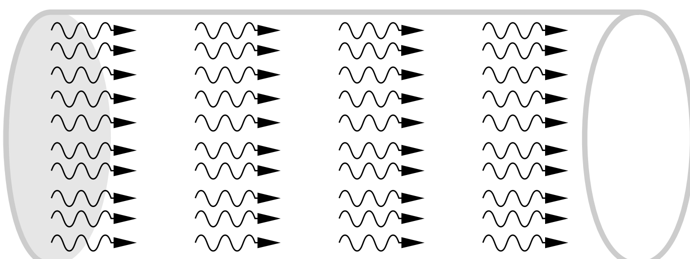
PHYSNET

MISN-0-257

OPTICAL PUMPING



Project PHYSNET Physics Bldg. Michigan State University East Lansing, MI

OPTICAL PUMPING

by

Frank Zerilli
Michigan State University

Title: **Optical Pumping**

Author: Frank Zerilli, Michigan State University

Version: 2/1/2000 Evaluation: Stage B0

Length: 1 hr; 8 pages

Input Skills:

1. Calculate the wavelength and frequency of a photon emitted or absorbed when an atom makes a transition from one given state to another (MISN-0-216).
2. Describe the distribution of energies of a collection of atoms in thermal equilibrium (MISN-0-159).

Output Skills (Knowledge):

K1. Define spontaneous emission.

K2. Define stimulated emission.

K3. Define population inversion.

K4. Explain the basic principle of laser operation (optical pumping).

External Resources (Required):

1. Weidner and Sells, *Elementary Modern Physics*, 3rd ed., Allyn and Bacon (1980). For access, see this module's *Local Guide*.

Post-Options:

1. "Laser Devices" (MISN-0-258), learner originated.
2. "Optical Circuits" (MISN-0-259); learner originated, introduce the latest high technology applications of the principle of optical pumping.

THIS IS A DEVELOPMENTAL-STAGE PUBLICATION
OF PROJECT PHYSNET

The goal of our project is to assist a network of educators and scientists in transferring physics from one person to another. We support manuscript processing and distribution, along with communication and information systems. We also work with employers to identify basic scientific skills as well as physics topics that are needed in science and technology. A number of our publications are aimed at assisting users in acquiring such skills.

Our publications are designed: (i) to be updated quickly in response to field tests and new scientific developments; (ii) to be used in both classroom and professional settings; (iii) to show the prerequisite dependencies existing among the various chunks of physics knowledge and skill, as a guide both to mental organization and to use of the materials; and (iv) to be adapted quickly to specific user needs ranging from single-skill instruction to complete custom textbooks.

New authors, reviewers and field testers are welcome.

OPTICAL PUMPING

by

Frank Zerilli
Michigan State University

1. Program of Study

In WSM[1] study section 9-4. Note that the coherence of the emitted photons is related to the high intensity of the emitted light. Looking at the wave aspect of the emitted photons, coherence means that the waves corresponding to the photons are in phase. If we add the amplitudes of N waves which are in phase, the intensity of the resultant wave is N^2 times the intensity of a single wave. If the waves had random phase relationships, the intensity of the resultant would be only N times that of a single wave. For large N, N^2 is much greater than N.

Acknowledgments

Preparation of this module was supported in part by the National Science Foundation, Division of Science Education Development and Research, through Grant #SED 74-20088 to Michigan State University.

[1]R.T. Weidner and R.L. Sells, *Elementary Modern Physics*, 3rd ed. (Allyn and Bacon, Boston: 1980). For access, see this module's *Local Guide*.

LOCAL GUIDE

The readings for this unit are on reserve for you in the Physics-Astronomy Library, Room 230 in the Physics-Astronomy Building. Ask for them as "The readings for CBI Unit 257." Do **not** ask for them by book title.