and a photoelectric process transferring the photon's energy to the electrons at the zone boundary. The plausible theory presented is based on the concept of parametric coupling of electromagnetic waves at the bremsstrahlung limit $\lambda$, with the de Broglie electron waves $\lambda_n$ by the coupling equation $n\lambda = \lambda_n$, where $n$ is any integer greater than 1. The predicted discrete energy values of photons are 360, 127, 68, 42, and 29 keV for $n = 2, 3, 4, 5$, and 6, respectively. The predicted values agree well with the experimental results.

P.4A Distributed Feedback X-Ray Lasers in Single Crystals, Amnon Yariv and Avraham Gover, California Institute of Technology, Pasadena, Calif. 91109.

There are two main obstacles in the way of obtaining laser action in the X-ray region. The first involves the pumping necessary to obtain the critical inversion. The second is that of the optical feedback.

Estimates of the losses associated with potential X-ray media show that super-radiant laser action is not very likely in the 1 A $\approx \lambda \approx 10$ A region and that efficient low-loss feedback will be necessary to obtain laser action.

In this talk we will consider the problem of propagation of an X-ray laser beam inside a crystal lattice. We take the dielectric constant $\varepsilon(\vec{r})$ as a periodic function with symmetry properties identical to that of the crystal group and calculate the Fourier coefficients $a_{\vec{g}}$ in

$$\varepsilon(\vec{r}) = \sum_{\vec{g}} a_{\vec{g}} e^{i\vec{g}\cdot\vec{r}}$$

where $\vec{g}$ is the reciprocal lattice vector. We find that in certain classes of crystals Bragg reflection from the (111) to the $\{111\}$ direction provides an intense feedback for a beam with a wavelength $\lambda$ such that

$$d_{111} = \frac{\lambda}{2}$$

where $d_{111}$ is the atomic planar spacing along the $\{111\}$ direction.

An electromagnetic analysis of the propagation problem is combined with Kogelnik and Shank's distributed feedback analysis to obtain the laser threshold gain.

The possibility of crystals which, in addition to satisfying the feedback condition (1), have a $K_{\kappa}$ transition at $\lambda$ is examined. We find that such crystals exist only in the proper pumping conditions both amplification and feedback are possible in a single crystal with no external mirrors.

P.4B On the Possibility of a Distributed Feedback X-Ray Laser, Robert A. Fisher, Department of Applied Science, Davis-Livermore and Lawrence Livermore Laboratory, University of California, Livermore, Calif. 94550.

Although a number of X-ray laser resonators have been proposed, they all have cavity transit times which far exceed the typical X-ray fluorescence lifetimes. To implement the X-ray laser scheme in which the sample is to be pumped by a fast-rising (10$^{-14}$ s) pulse of X-rays, we suggest a distributed feedback design which incorporates the cavity and the active medium as one piece. This scheme has been successful for visible dye lasers. X-ray distributed feedback can be achieved by choosing a crystal with the appropriate periodic lattice spacing for backward Bragg scattering at the characteristic emission frequency of one of its constituents. This device has a far shorter cavity transit time, and it eliminates problems associated with the alignment of multiple elements. Since a number of experimental efforts are now under way, we suggest an additional criterion for selecting potential samples. With this distributed feedback, the required pumping power could be reduced and, thus, X-ray laser action could possibly be achieved at an earlier date.

Many emitting species can be considered. In the case of oxygen, the $K_\alpha$ wavelength is $\approx 23 \AA$. Numerous crystals have been found with approximately the appropriate spacing. A cubic millimeter would be more than sufficient, and the crystal would be destroyed in a single shot. For silicon, a good candidate is $\beta$-cristobalite ($SiO_2$); its $K_{\alpha}$ emission and periodic spacing differ by only one part in 10$^4$.

In the scheme presented here, the electron density distribution must remain periodic while inversion is established. We can estimate the "melting time" of a pumped crystal by the following argument. We assume that the singly ionized ion satisfies the one-dimensional equation of motion

$$\chi'' + \chi = 0$$

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