# NASA TECH BRIEF

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## Soft X-Ray Lasers Using Distributed-Feedback Reflection: A Concept

It has not been possible to construct an X-ray laser because no known mirror will reflect X-rays and produce a reinforced coherent beam. It has now been proposed that an X-ray laser could be made using distributed feedback instead of mirrors for reflection and coherent reinforcement. The channels in molecular-sieve crystals (e.g., zeolites) could be filled with a gas such as neon which would be excited to emit photons. Bragg scattering of the photons by periodic lattice planes in the zeolite would reflect and reinforce the photons, and channels in the crystals would serve as waveguides.

Zeolites are aluminosilicate crystals with porous structures with one-, two-, or three-dimensional channels having diameters of from 3 to 12 Å. Neon gas at very low pressures could be introduced into the channels. Electron bombardment of the gas could form $Ne^{+}$. This would cause K-shell fluorescence and produce photons in the soft X-ray region. The photons would be scattered at the periodically-located lattice planes in the crystals.

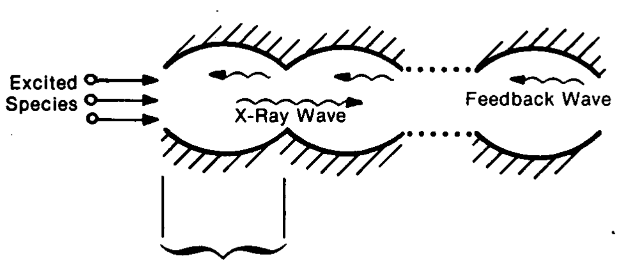


Figure 1. Distributed-Feedback Reflection

The wavelength of the neon K$\alpha$ emission is at 14.6 Å, and a zeolite with channel periodicity one-half that would produce scattering at each site which would be in phase with scattering at all the other sites. Because of the higher index of refraction within the channel, it should act as a waveguide to produce a coherent beam. Figure 1 is a diagram of how distributed reflection would occur in a zeolite channel.

A proposed arrangement for an X-ray laser is shown in Figure 2. A large evacuated chamber contains a smaller Dewar chamber into which liquid neon is introduced. A zeolite crystal is mounted in the wall of the chamber, with one side in contact with the liquid neon and the other exposed to the evacuated chamber. An electron gun, aimed by electromagnetic deflection, is used to bombard the zeolite crystal.

A detector (with a beryllium shield to stop scattered electrons) is used to aline the electron optics to get the maximum channeling. Before the neon is introduced, the Faraday cup is moved to get the best electron path as measured by the detector.

Liquid neon is then allowed to diffuse through the crystal channels, and the crystal is bombarded with electrons. This should generate a plasma in the gas mixture (neon with selected amounts of helium impurity admitted) leading to an inversion of ionized states in the neon. The helium provides $He^{+}$ for the neutralization of space-charge buildup.

The lasing action could be adjusted by varying the power of the electron-beam gun and varying the temperature of the crystal. It is anticipated that neon K$\alpha$ line widths on the order of 1 to 10 meV will be obtained.

(continued overleaf)

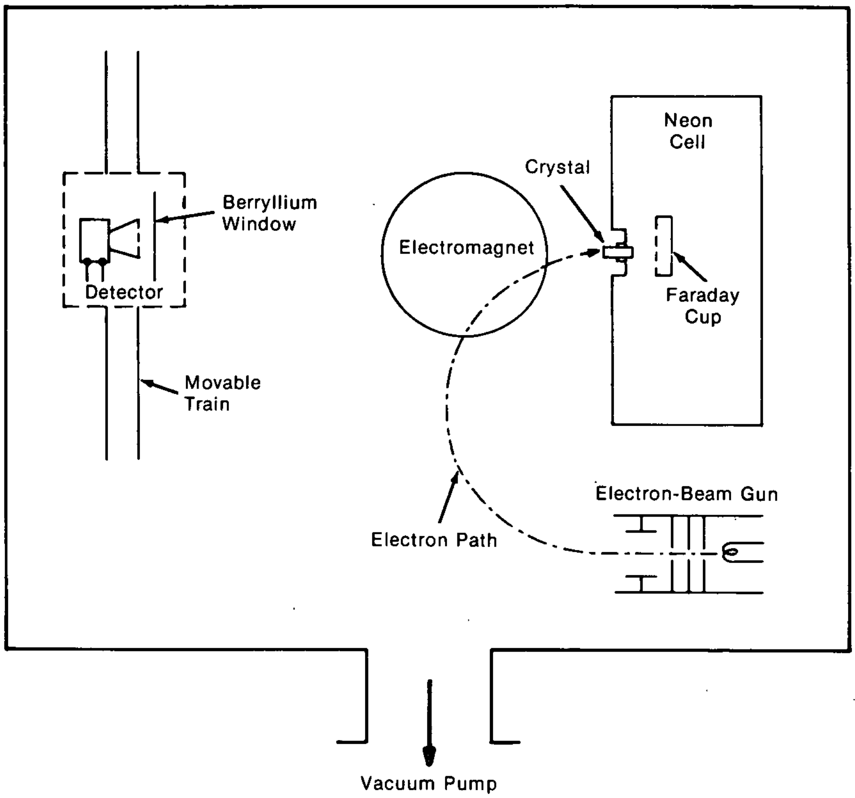


Figure 2. Proposed Configuration of X-Ray Laser

**Note:**

Requests for further information may be directed to:

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**Patent status:**

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