Hard X-ray emission lasers from neon like selenium Se^{+21}

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Hard X-ray emission from neon like selenium were Predicted to be emitted. The atomic data were relativistically calculated. A 457 energy levels were considered with four possible transition types (E1, E2, M1 and M2). Electron impact excitation were calculated using the effective collision strengths through the distorted wave approximation technique. All laser lines with gain coefficients ≥ 1 were determined. Population inversions, Doppler broadening are calculated for the highest gain transitions.

X-ray lasers are a class of lasers that have a wavelength ranges from 2 nm to 50 nm. Producing such lasers faces the problem of getting a high power excitation energy for the atoms to produce the population inversion. X-ray lasers need a special set up for getting such power energy. X-ray laser wavelengths are not affected by dense plasmas either by reflection or diffractions, which makes these lasers as a good tools in studying such plasmas, that improves our knowledge in the nuclear fusion or in astrophysics.

Since 1960 lasers become an essential tools in our life. Lasers can be used in surgery, industry and in lots of applications like laser printers. Lasers have a monochromatic and collimated beams of light.

In X-ray lasers, atoms with high number of electrons was suggested by Peter L. Hagelstein. Hagelstein suggested using a thin foil of selenium or molybdenum. The proposed model was as the following, when a high energetic beam of radiation falls on a thin foil of a material such as selenium, then the outer shell electrons can easily collide with the selenium plasma which are now Ne-like (Se^{+24}) and then an inner electron is excited to a higher energy level. These type of excitation is called collisional excitation.

In 1972, the first X-ray laser experiment was proved. In that experiment a Q-switched Nd:glass laser with 1.06 μm wavelength, 20 nm pulse duration and 30 Joules per pulse was used. The target was aqueous copper sulfate ($CuSo_4$) gel with different concentrations of copper. When the laser beams falls on the copper target a collimated radiation was detected by a photographic plates, like the medical X-ray films. These photographic plates were wrapped by one to four layers of Aluminum with 13 μm thickness to prevent soft X-ray radiation from detection. It was found that by placing the photographic film at 30 cm and 110 cm, the spot size of the emitted radiation remains the same 0.01 cm in radius which means that the output radiation is collimated hard X-rays. In that experiment, the wavelength was not measured and no one could get the same results. In 1975, a seminal review paper about X-ray lasers predicts that the population inversion density should exceed 10^{18} cm^{-3}. In order to use lasers as a pump power to get shorter wavelengths (≤ 1 nm) we should focus the laser of power (> 10^{12} W) into a very small spot with diameter (< 30 μm). It was also shown that the main dominant process is the spontaneous emission in producing the X-ray lasers this emission is called amplified spontaneous emission

(ASE). In 1985, It was first experimentally proved that emission of two bright lines from selenium with wavelengths 20.63 and 20.96 nm with gain coefficient 5.5 cm^{-1}.

In 1998, a new technique for the pumping was checked, by using two laser pulses one with 5 J every 800 ps which ionizes the plasma and other laser has 5 J every 1.1 ps which excites the produced ions. Using that it becomes possible to get high gain coefficient 35 cm^{-1} from Nickel-like Palladium from 4d → 4p transition with a wavelength 14.7 nm.

Recently a laser transitions from Ne-like Ti, V, Cr, Fe and Co were detected. Using a laser pulses with a delay time, we could detect a 3p → 3s transition and the emitted wavelength from Ne-like Ti was 30.1 nm. Also inner shell X-ray lasers were proved from neon gases by 960 eV photon energy emitting 1.46 nm wavelength with gain coefficients of 61−70 cm^{-1} . Short laser wavelengths (≈ 6.85) nm were also detected in Ni-like samarium.

In this report we try to obtain a short wavelengths from neon like selenium at different electron energies. The data are compared with the experimental results.