Preface

Firefly light is a common sight of summer evening. Actually this light is the result of a series of chemical reactions which occur within the body of that insect. The phenomenon due to which firefly produces light is called bioluminescence. Bioluminescence is the luminescence produced by living organism. The importance of firefly bioluminescence lies in the fact that this light producing mechanism of firefly is very efficient. The reported high quantum yield value for this reaction is a manifestation of this. The reaction is called chemiluminescence reaction. The main molecule that is involved in this reaction is luciferin. With the help of the catalyst luciferase, luciferin molecule gets converted to luciferin adenalyte and then goes to the excited oxyluciferin state. While coming to the ground state it produces greenish yellow light. The wavelength range emitted by firefly varies slightly with species.

This thesis is an attempt to study some aspect of the light of an Indian species *Luciola praestita* Kiesenwetter 1874 (Coleoptera: Lampyridae: Luciolinae). Both steady state and time resolved studies were done for this particular species. In comparison to this the spectra of two Japanese fireflies *Luciola cruciata* and *Luciola lateralis* are also presented here.

The emission spectrum on colour film was recorded by Hilger & watts glass spectrograph and analysed in the steady state experiment. The same spectrum was also recorded on the Ocean Optics HR 2000 Series high - resolution spectrometer. The software Image J was used for the analysis of the result. In these spectra three colours were observed. They were green, yellow and red. Most striking part was in the yellow sector which was observed to be very narrow. While studying its intensity profile this
narrow sector shows a sharp increase in the intensity. The spectrometer reading also points towards this gain narrowing. To remove the noise-signal conflict a zero signal spectrum was also recorded and was subtracted from the firefly spectrum which then confirms the yellow line as a signal. The FWHM measured to be 0.25 nm or 2.5 Å. This value is also limited in the sense that the resolution of the spectrometer is 2.2 Å. This shows that the value of FWHM may be even less than that of 0.25 nm. As possibility of a cavity inside the firefly lantern is almost negligible, the lasing action was hypothesised to be due to random laser. Thus firefly light was hypothesised as a random laser emitting in the yellow region.

After getting the sharp line the next steady state experiment was to record the diffraction pattern. A grating of 15000 lines per inch was used for this experiment. Here no lens was used to collimate the beam; the diffraction pattern was an impure one. In the diffraction pattern again three colours were found. Here the central principal maximum was found to be predominantly yellow. The other two colours were found from first order only. The yellow colour was appeared to be very narrow in the first order and almost invisible in the second order. This indicates that the wavelength spread of the yellow colour is very small. This analysis points towards the coherence nature of firefly light. The spectra of two Japanese fireflies also showed the same result.

In the time resolved study the seasonal variation of firefly flash and its effect under the magnetic field was observed. The firefly flashes were recorded at different temperature of different season with the help of a photomultiplier tube and a digital storage oscilloscope. The flashes recorded were analysed with the software Origin 6.1. The result showed a linear relationship between firefly flash and the temperature. The effect of temperature on catalytic activity of firefly luciferase was thought to be the cause of such variation.
Thus the broadening of the firefly flashes in winter season (< 23 °C) is probably due to the slowing down of the chemilluminescence reaction.

In another time resolved study the firefly flashes were done under strong magnetic field. The flashes were recorded in a digital storage oscilloscope. The firefly was put into the centre of the superconducting magnet of intensity 10 Tesla to study the effect of magnetic field on its flash. These flashes were found to be affected by the strong magnetic field due to its affect on the nerve conduction due to the Lorentz force. The flashes under magnetic field and without magnetic field are Fourier transformed. Fourier transformed plots showed surprising result. Under magnetic field some of the harmonics disappeared which were present in the absence of the field. The disappearance of the harmonics occurred in a regular interval. Thus magnetic field affects the firefly flashes by filtering a few harmonics which is analogous to a Notch filter.

Thus in all the five chapters of this thesis, the light of the firefly was studied in detail which gives an idea of some characteristics of firefly light, its time resolved flashes and dependence on various stimuli like temperature, magnetic field etc.