Experimental Physics - II
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Lecture - 08
Basic Components

Now, in this Experimental Physics II, we will discuss optics experiment as well as some experiments on quantum physics. What we expect about the optics laboratory. How it should be? Let me tell you how it should be and what are the basic components should be in the laboratory.

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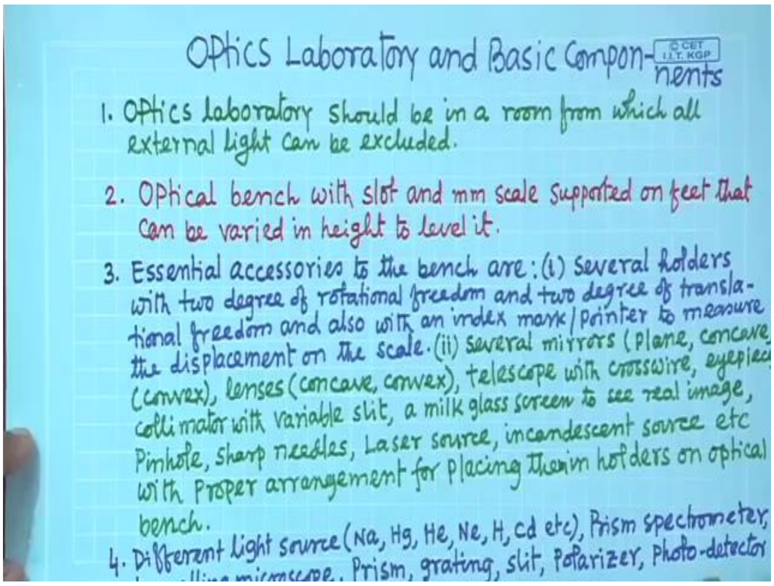

In optics laboratory, this laboratory should be in a room from which all external light can be excluded. In that room there should be provision it may not be completely dark room but there should be provision for preventing the light coming from the outside external light. That arrangement should be there in the optics laboratory and in optics laboratory most useful component that is optical bench with slot and millimeter scale and this optical bench should be supported on feet that can be varied in height to level it.

In optics experiment leveling of the component is very important because you know that reflection, refraction mainly everything it is a light, it is a, it is related with the reflection, refraction some other phenomena also there. If mirror is slightly tilted or light will go in different directions. To get the light in a proper direction, alignment of the optical components are very important and that is the difficult part in the optics experiment.

One has to do very carefully and step by step there are some rules. One has to follow and then it will be comparatively easier. There should be optical bench in the laboratory and that bench should be using the spirit level that bench first initially that bench should be level horizon horizontal. To make it horizontal because this bench you are putting on a table this table may not be the perfectly this surface is not perfectly the horizontal.

It should not defend on the table. this your optical bench should not provision to adjust the height. That is why this optical bench have feet. It is the screw, it is; it put on always have (Refer Time: 04:21) screw. You can just rotating the screw you can change the height of the 1 (Refer Time: 04:35) or yeah or other end of the table bench. Putting this what is called, spirit level, you have to first you have to make the optical bench horizontal; that is very important. There should be optical bench and there should be millimeter scale we generally tell this meter scale attached with this optical bench and there should be a height adjustment for the bench height adjustment option for the bench for leveling it.

then essential accessories to the bench for this on the bench accessories necessary essential accessories are several holders. These holders will put on the slot of the optical bench and this holder can translate we can move the holder along the slot along the slot and also this holder it is how you tell also up right

This holder will have option to hold some optical component on it, several holders with two degrees of rotational freedom and two degrees of translational freedom. Along the slot you can move that one apart from that this holder should have two more translational freedom.

One is height adjustment and another is perpendicular to the slot or optical bench you can move this holder. Minimum two degrees of freedom you need one is height adjustment and another is perpendicular to the slot and third one it is a all the time it is there.

we can move towards the along the slots and two rotational freedom means this holder you can rotate tilt along this or along this. Because optical component will be attached with that that optical component we have to make vertical there should not be any tilt etcetera. to adjust this those things we this holder should have rotational and translational degrees of freedom. These are very important otherwise it is a very it becomes very difficult to align the optical component for different experiment.

Also this holder should have should have index mark or pointer to measure the displacement on the scale. Optical table have scale right optical table have scale, you are putting the holders in the slot of the optical bench. Now this holder should have a marker should have a marker or one mark or index in the middle position actually these whatever component you will put on this holder.

Depending on the position of the component on the holder exactly on the base of the holder, there will be a mark. That mark or pointer actually will be used to read the position of the holder on the optical bench. This is the essential accessories ah for the bench. Apart from that in the laboratory there should be several, there should be common components that any times you may need those components for optical experiment, those are mirrors.

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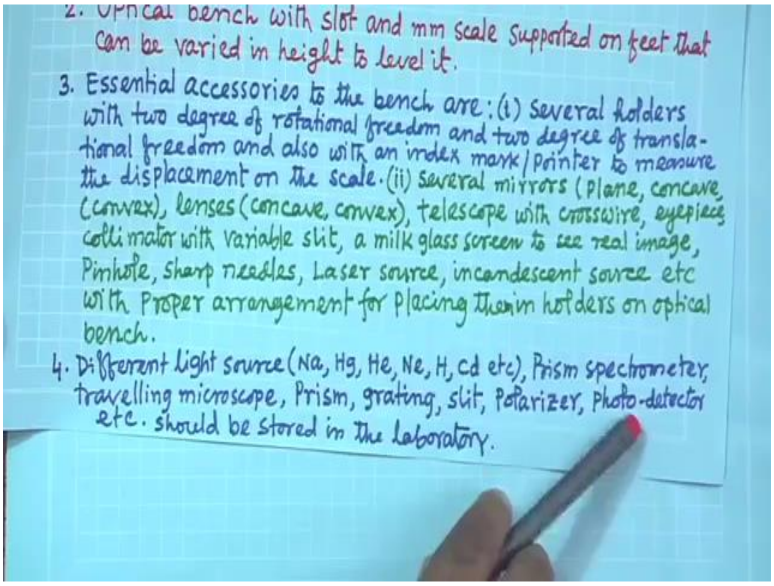

You should have in there should be several mirrors plane mirrors, concave mirror, concave convex mirrors, lenses, concave lenses, convex lenses, then telescope with crosswire, eyepiece; I think eyepiece with eyepiece with eyepiece, then collimator with variable slit. If milk glass screen white screen to see the real image pinhole, sharp needles, laser source, incandescent source etcetera with proper arrangement for placing them in holders of the optical bench.

These are the very common components for the optical lab mirrors, lens, telescope, eyepiece, and collimator, screen this pinhole, needles, and laser some optical source. Laser source some other bulb source or discharge source. Only these are these are not enough now these there should be proper arrangement to put them on the holder which will be used on optical bench.

These arrangement are very essential; without them it is very difficult to do the experiment because it will be time consuming to align them if you have proper holder and then this ah some good arrangement to hold the components and with some rotational translational freedom of the holder. Then comparatively it will be easy and you will you can save your time to do the experiment.

These are the very common components in the laboratory. Then you need different light source. Generally this sodium light source, mercury, helium light source, neon these generally these are the source we use in our teaching laboratory. Then you need prism spectrometer, travelling microscope, prism, grating, slit, polarizer, photo-detector etcetera. It should be stored in the laboratory; this these are whatever this should be, this optics laboratory should be like this.

Whatever I told here these are the very basic components. It is not for a, it is not that this for a particular experiment whatever need that is only there. There should be these are the just it is like a movable ah components, it is like the just like screw and nut bolt, screw driver kind of things.

In the optics lab these are the, these kind of things any times you may need any components. It should be stored in the laboratory optics laboratory and for the different experiment you need different things. That is different story but whenever you will go to optics laboratory. This should be the environment of the laboratory.

Whatever components I told you here whatever things I told everything I will show you in laboratory. When we will do some experiment and every components I will show you in laboratory and also I will discuss how it works. here what I will not discuss there I will not discuss about the light source there but light source is one of the component one of the important component for optics experiment. now I will discuss about the light source here. Rest of the components I will discuss in the laboratory during the experiment.

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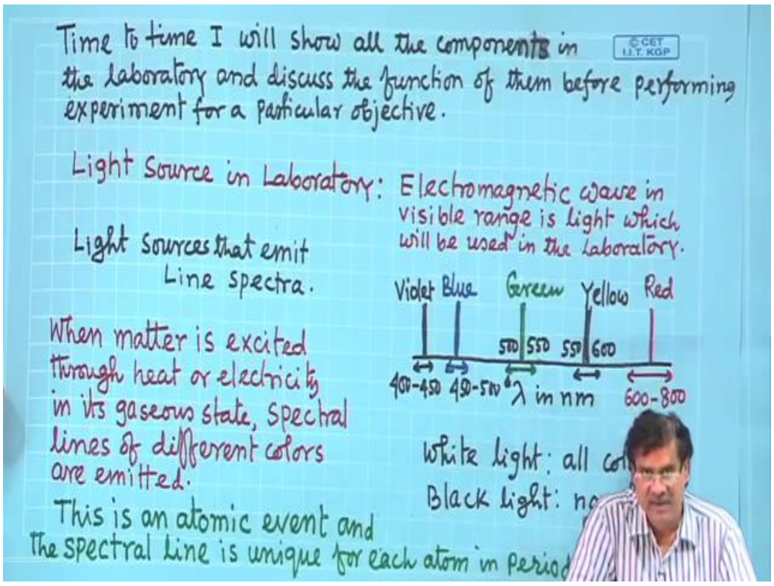

That is what I told this time to time I will show all the components in the laboratory and discuss the function of them before performing experiment for a particular objective. Light source in laboratory it is electromagnetic wave in visible range that is that is what light we tell. Although electromagnetic wave have (Refer Time: 15:56) range but visible range that we tell it is light which will be used in our in the laboratory in teaching labs specially. In the visible range; we will get different color basically.

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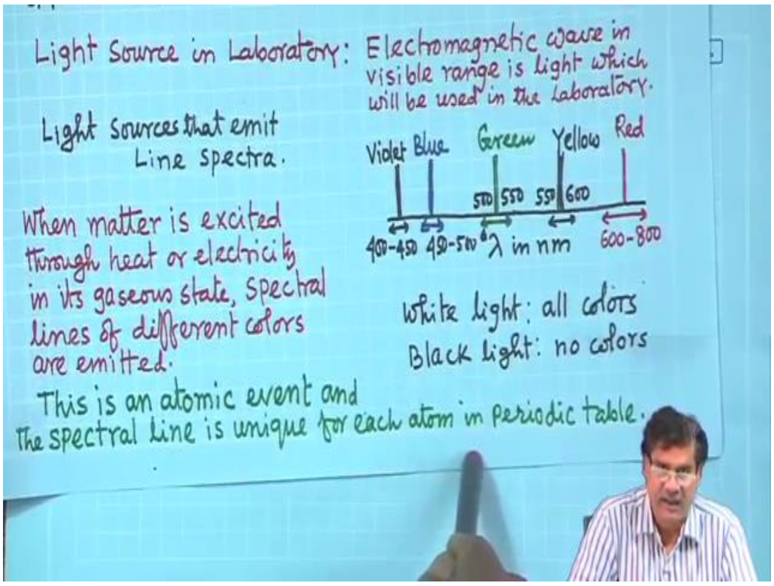

This red color this wave length range when wavelength range of electromagnetic wave is it is approximately 6 to 800; 6 to 800. See in that range you tell red then this side is around 600 that say orange you tell this color is orange then this yellow color. Generally it is the 550 to 600, it is a yellow color, green color 500 to 550 in that range green color this range is not it is a roughly I mentioned here, blue color 450 to 500. That is a blue color, violet color that is 400 to 450 that is the violet color. There are range of this wavelength.

For different source you will get different color and their wavelength are fixed. Their wavelength are fixed that red color same color, but wavelength for some source it will be 680, some source it may be 700. Similarly for other color also same color will not tell the wavelength, it will tell the range of the wavelength but for a particular source that color light of a particular color will have a particular wavelength. We get the light.

There are two ways this light source that emit continuous wavelength and there are light source that emits line spectra discrete wavelength. In our laboratory we will use light which are emit line spectra or discrete wavelength of light. for light source that emits line spectra that when we get this type of source when matter is excited through heat or electricity; in its gaseous state spectral lines of different colors are emitted.

This is an atomic event and the spectral line is unique for unique for each atom in periodic table. this discrete color we are getting lines we are getting lights of discrete wavelength we are getting that is atomic phenomena and as I mentioned that each atom in the periodic table have a characteristics, characteristics light characteristics light.

That means, it has fixed wavelength. That is why for light for different wavelength if you want; you need to use different source. Let me just tell you what are the source we are using in the lab or we will use in the lab during our experiment.

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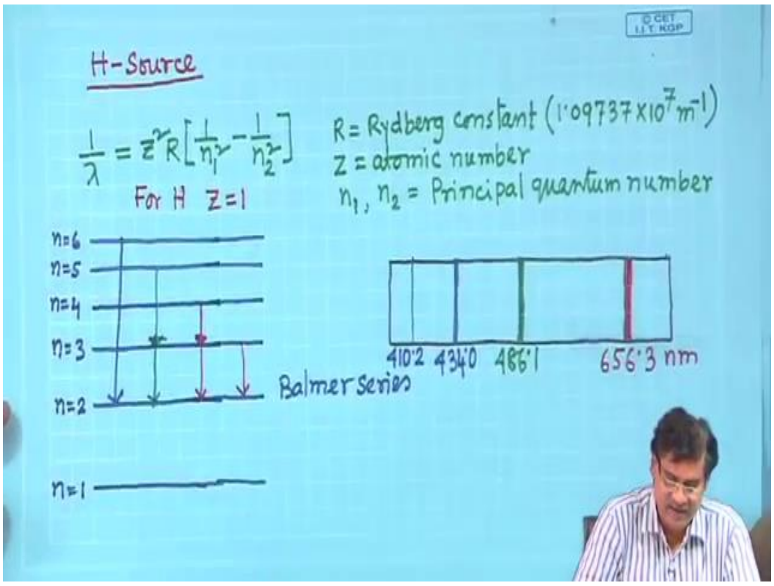

We will use hydrogen source; we will hydrogen source this (Refer Time: 20:36). how it is, it is I have used this example first because you are quite familiar with this hydrogen energy levels right. from Bohr theory you know this 1 by lambda wave number, equal to Z square R; 1 by n 1 square minus 1 by n 2 square.

this is the hydrogen or hydrogen like atom means in that atom or ion only 1 electron are there other electrons are removed. For hydrogen it is a Z equal to 1. in our principle quantum number R is the Rydberg constant; it has some value. n equal to 1, 2, 3 these are the energy levels right for hydrogen. Now in a hydrogen one electrons are there when either hitting or through electricity if we excite these hydrogen atoms hydrogen gas.

The electrons generally it is in ground state it goes to the higher energy states and now in the higher energy states it stays only very small times. Generally 10 to the power minus 8 second and then it jump back to the lower energy state.

When it jump to the lower energy state. From hitting or from electricity it gain energy and goes to the higher energy levels when it jump to the lower energy levels. The energy difference between these two levels. That energy actually comes out as a electromagnetic wave; now when that wave is in the visible range.

Then you will see the light and that light what will be the color that will be decided from this wave length right. In case of hydrogen there are different series, you know this Balmer series in the; in the Balmer series is in the visible range. if we use hydrogen source in laboratory when we will use hydrogen source in hydrogen source what about light will come out and that light we will use for our experiment and there this you will see this type of line spectra.

One line you will see this is a red color you will see that is the 656.3 nanometer. These are from the handbook you will get this value of the wavelength of this line spectra. Generally these are the there are other lines also; may be not for this source for other source but all lines are not intense. There are weak lines, there are strong lines, and there are medium lines.

Here for hydrogen this typical wavelength of light we will get. This is the 656.3 nanometer then 486.1. These are not the color exactly yeah maybe it is because I did not have all sorts of color, I have 4 colors. I try to just adjust with them 486.1 nanometer, another line you will get 434.0 nanometer, other one 410.2 nanometer. These are the prominent lines prominent intense light you will get of these wavelength. This source we use in our laboratory then second source we use in our laboratory that is sodium source.

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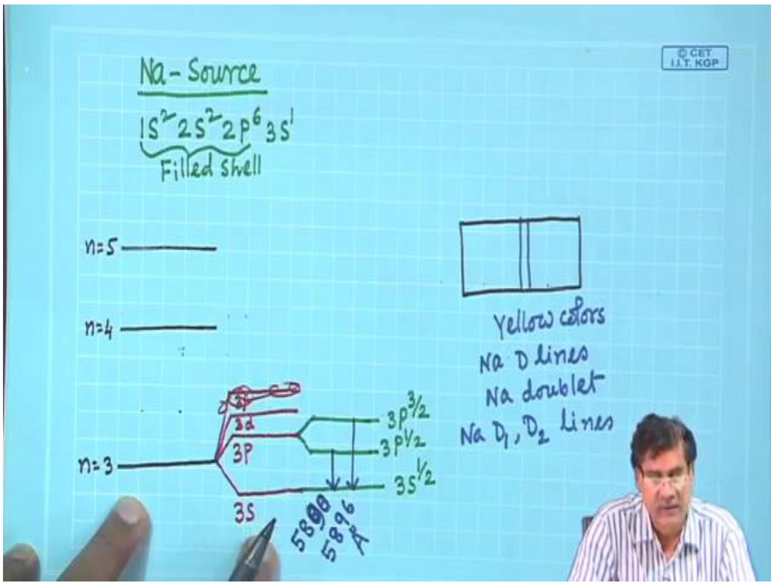

For sodium source again this 11 it atomic number is 11. it is the this last electron it is the on 3 s 1, these are filled shell. This electron generally it is exited to the higher energy state and higher energy state and it produce the light.

n equal to 3; this n equal to 3; n equal to 4; n equal to 5 there these are energy levels, now it is n equal to 3; n equal to 0, 1, 2; is s p d. it has 3 sub level s p d; no 4 sub level I think 0, 1, 2 yes 3 sub level s p d, not f I think I did mistake not f; s p d. this in case of hydrogen this was not there, oh it was there, but they had same energy it is a degenerate states.

In this case this their degeneracies are removed due to presence of the other electrons in case of hydrogen it was not there. In presence of other electrons in presence of other electrons due to the interaction or effect of the other electrons, these degeneracy are removed.

Now there are spin orbit coupling spin orbit ls coupling spin orbit coupling gives j value. Again they are splitted; again they are splitted. for s l equal to 0, and then spin half, j is half. 3 s half this state it is called 3 s half and p l equal to 1 and s equal to half. j will be l plus half l minus half.

p half and p 3 by 2 and these three principal quantum number, there are others also. in case of sodium we get this these two lines these two lines in the feasible range there are the other transitions, but they are not in visible range. We cannot see we only see this we only see these two ah spectra lines. The wave length is 5890 and 5896, 6 angstrom difference between these two light.

In generally we see them as a one line; it is very difficult to resolve them. Even through prism ordinary prism we cannot resolve them; we will see only one line. that is how we tell it is a monochromatic source yellow and this is this is in the range of 550 to 600, this is the range of yellow color.

This sodium yellow color light we see that we tell D line and this we tell sodium doublet because it has two line D 1 and D 2 line and wave length is 5890 and 5896. average wave length we consider when we do not see this doublet as I told these difference are very small only with high resolve spectrometer you can resolve them, otherwise in ordinary spectrometer you can see only one line and average wave length we take 5893. This sodium source is a very essential source all the time we need this source and we will use them that is why I discussed what the origin of them is.

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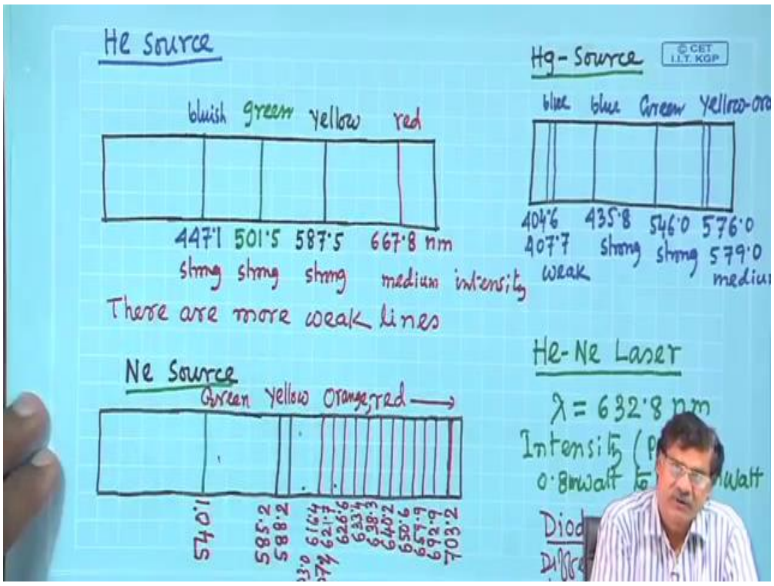

Then helium source that is also we will use this for helium source. again this atomic transition from lower level to higher level electron goes absorbing the heat energy or the electricity electrical energy and then immediately it come to the lower level and gives the spectral lines whatever the principle for hydrogen I have discussed sodium; I have discussed for this also same principle.

Number of electrons or more things to exactly find out this transition is slightly difficult but we are not going to that only we learnt that this is the atomic transition. Due to the transition of electrons from one level to another level we are getting this light and this is the characteristics of that source whatever the light we are getting that is the characteristics of the source.

Helium source also we will use in our laboratory and this type of spectra you will get and you will get these are the wave lengths. These are the wavelengths and they have these have strong intensity and these have all although it is the medium intensity; there are more and their intensity are very weak and then mercury source we will use in our laboratory there you will get light of this wave length, light of this wave length. and here also there are some other lines weak lines it is difficult to see them generally but these lines are prominent.

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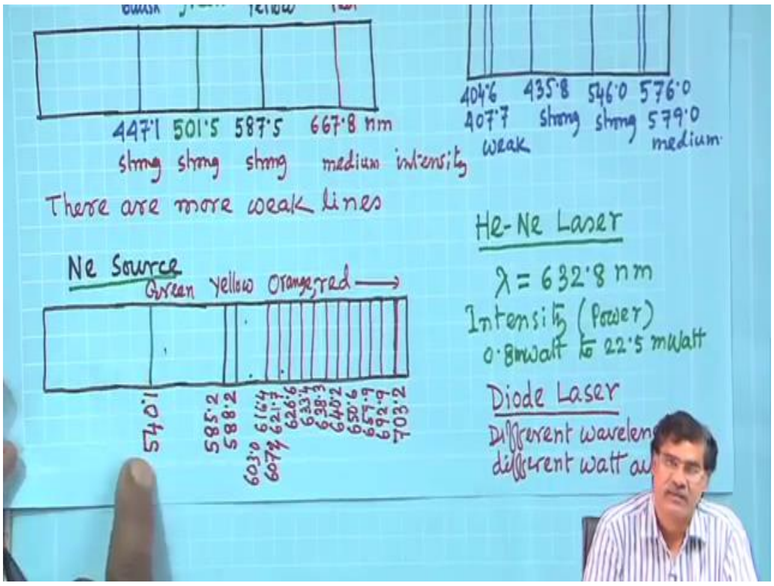

And then another source we use in the laboratory the neon source and for neon source you will get lot of lines in the range of 600 to 700 wave length. all are more or less red color and this side it will be orange color then we get two lines the yellow; yellow color but they are it is the doublet wherever you are getting doublet.

That comes due to spin orbit interaction due to the spin orbit interaction what are the splitting of the energy level because of their that generally we get this doublet structure. They have very close they have very close wave length and very prominent green color we see for neon source. from the color itself and from the data table you can say what is the wavelength of this also we can measure the wave length that is what the experiment we will do using the different source, how to measure the wave length of that source.

Also we use in the laboratory that is laser generally helium-neon laser; its wavelength is 632.8 nanometer helium-neon laser. That we will use in our laboratory for some experiment and it is intensity it is expressed in terms of watt, wavelength as well as watt of different for different intensity it is a defined as a different watt, also we will use diode laser. Different diode lasers are available of different wavelength. There are various kind of wavelength various kind of lasers and they have various kind of wavelength.

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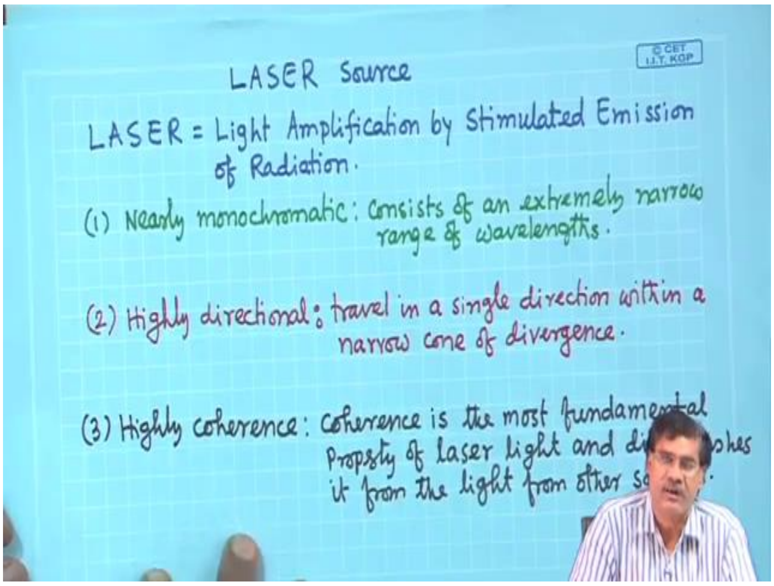

What are the advantage of laser source laser source you know light amplification by stimulated emission of radiation how it works etcetera I am not going to discuss. But it has unique property you know it is a nearly monochromatic, it is nearly monochromatic it is a high directional this laser source is highly directional and it is a highly coherence; it is a; what is coherence I will explain when I will do the interference experiment.

These are the unique property of the laser light, that is why laser light in our laboratory just for in some experiment we will use laser light but for other high end experiment for research laboratory this without laser we cannot think. There are lot of application for doing the experiment in research laboratory we use different kind of lasers.

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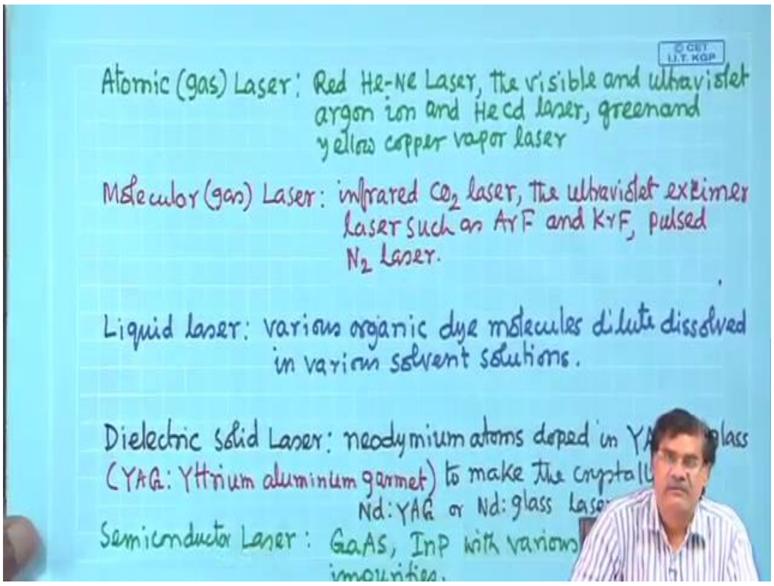

If you if you see the action function of the laser how we get the lasing light? That we tell atomic laser it is a gas laser as helium-neon laser as I told, otherwise this other visible and ultraviolet argon ion laser, helium cadmium laser, then green and yellow color yellow copper vapor laser. Hence we get the green and yellow color from this lasers. These are the gives monochromatic means one wavelength laser. These are one wave length laser.

This wavelength are fixed for those laser; only intensity we can vary for different watt. Then molecular laser it is also gas laser carbon dioxide laser then excimer lasers, pulsed nitrogen laser. These lasers we will not use these are for these are used for specific purpose for higher end experimental research laboratory.

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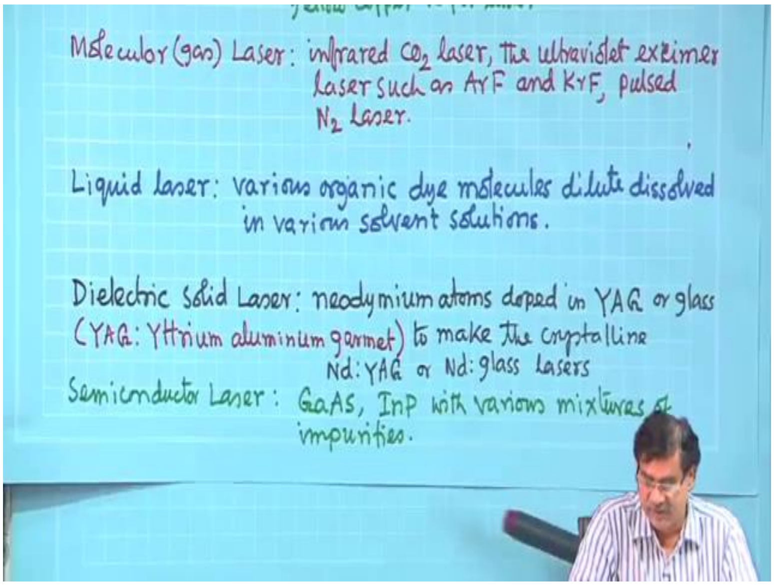

Just I am mentioning here some liquid lasers are there, dielectric solid lasers are there, neodymium doped this YAG; YAG is Yttrium aluminum garmet or to neodymium doped glass laser. These are the different kind of laser and this we use in our laboratory not for teaching laboratory for other purpose. Also semiconductor laser it is made of gallium arsenide, indium phosphide with various mixtures of impurities.

These are the briefly I told about the light source for visible range we will use in laboratory and some of them we use in the research laboratory just I mentioned them here. About other components I will discuss during the experiment in the laboratory. I will stop here.

Thank you.