

[21:19] <BrianQ> Anyways, let's do a quick review to warm up... recall hydrogen states, indexed by quantum number n ?

[21:20] <BrianQ> and their energies?

[21:20] <doos> yes

[21:20] <BrianQ> It takes a certain amount of energy to create a first excited state ($n=2$) from the ground state ($n=1$)

[21:21] <BrianQ> which corresponds to some small wavelength ultraviolet photon

[21:21] <BrianQ> so... an atom has to absorb either all the photon energy or none.

[21:22] <BrianQ> It can't absorb part of the photon's energy

[21:23] <BrianQ> Let's do a little thought experiment.... let's say you had a source of photons with exactly the right energy to create $n=2$ from $n=1$ state in hydrogen

[21:23] <BrianQ> This source blips out one photon at a time, and then somewhere down the line we put a detector

[21:23] <BrianQ> The detector counts each photon as it arrives.

[21:24] <BrianQ> ok, so far?

[21:24] <@Spauwe> roger

[21:24] <DragonStek> yup

[21:24] <doos> yes a photon multiplier

[21:24] <BrianQ> ok, now with nothing between the source and detector, each photon arrives and is counted.

[21:25] <BrianQ> But what happens if we stick a hydrogen atom between the source and detector?

[21:25] <doos> it would absorb the photon and then release it

[21:25] <@Spauwe> non arrive

[21:25] <Frank8> the photon disappears and the hydrogen electron moves to the $n=2$ shell

[21:25] <DragonStek> it jumps to a higher n shell

[21:26] <BrianQ> ok, let's start with the first of what doos says, which is basically what Frank is saying

[21:26] <BrianQ> and so the detector sees one less photon than what was emitted by the source, yes?

[21:26] <doos> yes

[21:27] <BrianQ> But let's go back to Doos second statement... what does the hydrogen atom do with that energy, eventually?

[21:27] <doos> re-emits it

—————01[21:27] <@Spauwe> as a photon?

[21:27] <doos> yes

[21:28] <BrianQ> yes, eventually it will re-emit it... now, does that mean our detector will eventually pick up that photon, so that the detector counts as many photons as the source emitted?

[21:28] <@Spauwe> not necessarily

[21:28] <BrianQ> why?

[21:28] <doos> depends if the photon is released in the same direction

[21:28] <@Spauwe> it may be emitted in any direction

[21:28] <BrianQ> yes, and yes

[21:28] <@Keirkof> it'll have changed frequency, no?

[21:28] <BrianQ> no

[21:28] <BrianQ> :)

[21:28] <@Keirkof> ^^

[21:29] <doos> interesting

[21:29] <BrianQ> the photon emitted by the hydrogen can be emitted in any random direction... which most likely won't be in the direction of the detector

[21:29] <BrianQ> so the detector never sees the photon.

[21:30] <BrianQ> We can scale this up to gemstone... why do we see a dark line in the spectroscope?

[21:30] <Frank8> will the emitted photon still have the same level of energy it started with?

[21:30] <BrianQ> In the case of an atom, Frank, the answer is yes.

[21:31] <BrianQ> There is no such thing as fluorescence in a single isolated atom

[21:31] <Frank8> ty...in the gem the dark line is the energy level which has been absorbed

[21:31] <doos> Brian, the photon is released in a different direction

[21:31] <BrianQ> But what happens to that absorbed photon, is what I am getting at, and Doos is answering ahead of schedule

[21:32] <BrianQ> In the simplest case, the reason we see a dark line is that the gemstone has diverted the photon of that wavelength from the straight path to our eye

[21:32] <Frank8> I thought it was converted to heat and / or light but after the above statements I'm not so sure

[21:33] <@Spauwe> ok...

[21:33] <doos> the photon causes the electron to go to a higher energy state, then the electron (or another) takes its groundstate and releases another photon in a different (or same) direction

[21:33] <BrianQ> that is also a possibility...

[21:33] <BrianQ> but... let's start with the simplest possibility before we get more complex

[21:34] <BrianQ> so... when you look at the sun through your spectroscope, you see the so-called sodium D absorption line, yes?

[21:34] <doos> yes

[21:34] <BrianQ> The sodium atoms in the sun's outer layer absorb that wavelength... but then what do they do with it?

[21:35] <BrianQ> they don't stay in that excited state forever, or even for very long at all.

[21:35] <BrianQ> So where does that energy go...

[21:35] <@Spauwe> guessing as usual: it gets redirected

[21:35] <BrianQ> yes, it goes in a different direction, basically, than along the path to your spectroscope

[21:36] <Frank8> question

[21:36] <BrianQ> yes Frank?

[21:37] <Frank8> If I circle the sun then the sodium line would be seen from any angle...if it goes off in another direction is there then a spot where the sodium line would be absent?

[21:37] <@Spauwe> in the sun's centre

[21:37] <BrianQ> Exactly

[21:38] <BrianQ> about half the light will be sent back toward the sun's center, rather than out

[21:38] <BrianQ> outward

[21:38] <BrianQ> so it never makes it out of the sun

[21:39] <BrianQ> I have this nifty atom+laser experiment that can be used for very high resolution spectroscopy

[21:39] <Frank8> I can see that but if the sodium is around the outer reaches of the sun then there wouldn't be a sodium line at the centre anyway as the light hasn't yet passed through the sodium layer

[21:40] <@Spauwe> it gets redirected in every direction

[21:40] <@Spauwe> so to the center as well

[21:40] <BrianQ> mm... at the center, the sun is creating light at every wavelength....

[21:40] <@Spauwe> but will be changed again on it's travel to the center

[21:40] <@Spauwe> is that right?

[21:40] <BrianQ> yes Tim

[21:41] <BrianQ> The sodium is on the outer surface of the sun, so it is like the atom stuck between the source and detector.

[21:41] <BrianQ> It IS the atom stuck between the source (sun center) and detector (our eye)

[21:42] <BrianQ> And as Tim says, if the light is sent back toward the center, it gets homogenized, so to speak

[21:42] <Frank8> ok ty

[21:43] <BrianQ> I have this nifty atom+laser experiment used for high-resolution spectroscopy that really demonstrates this principle in a direct manner

[21:43] <doos> mention the word homo and Frank understands

[21:43] <@Spauwe> ghehe

[21:43] <BrianQ> heh, another edit

[21:43] * doos behaves

[21:43] <DragonStek> lol

[21:43] <@Spauwe> I'll leave that in

[21:43] <Frank8> bastid

[21:44] <BrianQ> The center of the experiment is an evacuated glass cylinder. Inside the cylinder, coating the walls is atomic rubidium

[21:44] <BrianQ> a metal in the same column as sodium

[21:44] <BrianQ> so, you see a kind of metallic sheen on the inner surface.

[21:45] <BrianQ> Rubidium (Rb) has a low temperature for vaporization... so you wrap some heater wire around the cylinder

[21:46] <BrianQ> and heating the glass cylinder, you create a cell filled with nothing but single-atom gas

[21:46] <BrianQ> *but

[21:46] <BrianQ> ok so far?

[21:46] <doos> ok

[21:46] <Frank8> yes ok

[21:46] <DragonStek> yup

[21:47] <BrianQ> so the cylinder has circular faces at each end, and of course a long cylindrical side

[21:47] <CrystalStar> yes

[21:47] <BrianQ> You direct the laser beam so that it passes through one face and then out the other face

[21:47] <BrianQ> no light comes out the side, this way...

[21:47] <BrianQ> Now the wavelength of the laser is tunable...

[21:48] <BrianQ> you can shift its wavelength over a small range by twiddling some knobs.

[21:49] <BrianQ> And this range of wavelengths contains photon energies that can create two or three excited states of Rb from its ground state

[21:49] <BrianQ> This part is understandable?

[21:49] <doos> yes

[21:49] <Frank8> yes

_____01[21:49] <@Spauwe> yup

[21:49] <DragonStek> yes

[21:50] <CrystalStar> yes

[21:50] <BrianQ> we could refer to these as "resonance" wavelengths for exciting the Rb.

[21:50] <BrianQ> Now lastly, we stick a photon detector at the side of the cylinder, opposite the laser source.

[21:51] <BrianQ> oops... at the FACE of the detector, opposite the laser source

[21:51] <doos> on the opposite circular face?

[21:51] <doos> ok

[21:51] <BrianQ> yes, the opposite circular face

[21:51] <BrianQ> by the way, this range of laser wavelengths is NIR, so we can't see them with our eyes.

[21:52] <BrianQ> Which is good, because the laser is powerful, and so we should be wearing safety glasses anyways.

[21:52] <BrianQ> But a digital video camera (with its NIR filter removed) IS sensitive to the wavelength!

[21:53] <BrianQ> So... we point the video camera so that it images the SIDE of the cylinder.

[21:53] <BrianQ> Now, we turn on the laser and it is not set at a "resonance" wavelength...

[21:54] <BrianQ> What do our detectors see?

[21:54] <doos> nothing

[21:54] <Frank8> all photons pass through

[21:54] <doos> or little

[21:54] <DragonStek> nothing

[21:54] <@Spauwe> the camera nothing the detector all photons

[21:54] <doos> the photos are absorbed

[21:54] <BrianQ> nope... the detector at the circular face gives a huge reading because no photons are being absorbed

[21:55] <doos> uh?

[21:55] <@Spauwe> it's not set at a resonance wavelength

[21:55] <BrianQ> NOT set at resonance wavelength, maybe that part wasn't clear

[21:55] <doos> oh NOT set

[21:55] <doos> lol

[21:55] <BrianQ> heh

[21:55] <BrianQ> so... all photons produced by the laser travel a straight line and make it to the detector.

[21:56] <BrianQ> What does the video camera see?

[21:56] <doos> that wavelength

[21:56] <Frank8> a stream of IR energy passing along the cylinder?

[21:56] <@Spauwe> nothing

[21:56] <BrianQ> Yes Tim

[21:57] <BrianQ> nothing, because none of those photons are re-directed toward the camera...

[21:57] <BrianQ> they are all going to the detector.

[21:57] <Frank8> I thought the camera could "see" NIR energy?

21:57] <@Spauwe> nothing is redirected

[21:57] <doos> ok so the camera is not at the same place as the detector?

[21:58] <BrianQ> It can see IR, but no IR photons are being sent its way... they all follow the straight line through the cylinder between the laser and the detector

[21:58] <Frank8> ok I get it...no Doos the camera is at 90 degrees to the detector

[21:58] <doos> aha

[21:58] <doos> missed that part

[21:58] <BrianQ> Yes, the camera is looking at the SIDE of the cylinder, not at the circular face

[21:58] <doos> got it now thanks

[21:59] <BrianQ> Need to draw it up on the blackboard ;)

[21:59] <doos> heh

[21:59] <BrianQ> anyways...

[21:59] <BrianQ> now, I turn the little knob and the wavelength of the laser changes so that it goes through a resonance wavelength.

[22:00] <BrianQ> How do I know, experimentally, that I am passing through a resonance wavelength?

[22:00] <doos> the camera turns dark

[22:00] <doos> the detector goes on

[22:00] <@Spauwe> the camera will reveal light

[22:00] <BrianQ> the camera was dark before

[22:00] <Frank8> The detector counts less photons arriving and the camera sees flashes

[22:00] <BrianQ> the detector was full on before

[22:00] <doos> oh yes .. got it reversed again

[22:00] <BrianQ> yes, Spauwe and Frank are giving the correct analysis

[22:01] <BrianQ> The detector loses counts, maybe completely to zero. And the camera sees a bright line traversing the cylinder side

[22:02] <BrianQ> With this, we can infer that the Rb is absorbing the photons moving along one path, and re-emitting them along all possible paths

[22:03] <BrianQ> Ok that is pretty much how things go in atoms. So... we are familiar with the salt in the candle flame?

[22:03] <Frank8> yes sodium light produced

[22:03] <doos> it emits the d-lines

[22:04] <BrianQ> Use it to find the sodium absorption line with our spectroscope...

[22:04] <BrianQ> No doos, it absorbs the d-lines

[22:04] <doos> uh yes .. what is wrong with me today

[22:04] <BrianQ> In the same manner as the sun

[22:04] <doos> Brian, mark my paper reversed today and I'll pass with an A

[22:05] <BrianQ> heh, no doubt.

[22:05] <BrianQ> Now... we can continue to do just only a little more with atoms.

[22:06] <BrianQ> One could provide the hydrogen atom with a photon that would excite from $n=1$ to $n=3$ state.

[22:06] <BrianQ> That would be an even shorter wavelength UV than needed for the $n=1$ to $n=2$ transition, yes?

[22:06] <Frank8> yes

[22:06] <doos> yes

[22:07] <BrianQ> What would the hydrogen atom do with that energy? Again, it isn't going to keep it for long at all

[22:07] <Frank8> it would release it as two photons...one as it falls to the $n=2$ state then another as it falls to the ground state

[22:07] <doos> release it quantities

[22:08] <BrianQ> yes, what Frank says is the most probably thing that will happen

[22:08] <BrianQ> But there is a small probability that it will release one photon and go directly back to the $n=1$ state

[22:09] <BrianQ> So... two mechanisms that create the absorption line we'd see for an $n=1$ to $n=3$ transition (if we had UV eyes, of course)

[22:09] <BrianQ> One... the less probable mechanism that the entire energy is shot out away at some random direction

[22:10] <BrianQ> And two... the more probable reaction that a bit of red light (the $n=3$ to $n=2$ transition) is shot out in a random direction...

[22:11] <BrianQ> followed by a bit of longer wavelength UV light (the $n=2$ to $n=1$ transition) is also shot out in a random direction.

[22:11] <BrianQ> Now why isn't this second mechanism called fluorescence?

[22:11] <@Spauwe> it changes the wavelength

[22:11] <doos> because there is no loss in energy

[22:12] <BrianQ> it did indeed

[22:12] <@Spauwe> you asked why isn't?

[22:12] <@Spauwe> huh

[22:12] <BrianQ> but yes, the same amount of energy is present in photon form, so it isn't fluorescence

[22:12] <doos> well .. not an a difference in absorption and emitted energy that is

[22:12] <@Spauwe> ok

[22:13] <BrianQ> basically, the fluorescence mechanism is one photon in, one photon with longer wavelength out

[22:13] <Frank8> what happens to the excess energy?

[22:13] <BrianQ> the mechanism above is one photon in, two photons out... but energy in the photons is conserved

[22:13] <doos> it's the slowing down of light ;)

[22:14] <BrianQ> What excess energy?

[22:14] <@Spauwe> ghehe

[22:14] <Frank8> during fluorescence...the wavelength changes to one with less energy...what happens to the rest of the energy

[22:15] <doos> there is no fluor. in this case Frank

[22:15] <BrianQ> When you add the energy of the red photon and the energy of the longer-wavelength UV photon, you equal the energy of the short-wavelength UV that excited the $n=1$ to $n=3$ transition

[22:15] <BrianQ> Ha, yes, that's the point Frank, we haven't found the topic of fluorescence yet :)

[22:16] <Frank8> yes I understand this is true with the hydrogen atom we are speaking about but you also mentioned fluorescence I was wondering where the excess energy goes when UV light goes in and red vis comes out (in for example a ruby)

[22:16] <doos> gets transformed to other energy .. like heat

[22:17] <BrianQ> Ok... there we go... in order to have fluorescence, we have to have something like a molecule or crystal or something that atoms can interact with other atoms

[22:17] <BrianQ> I'll be right back and we'll continue this!

[22:17] <doos> ok

[22:25] <BrianQ> ok, lets imagine a series of balls connected by springs... ball, spring, ball, spring, ball

[22:25] <BrianQ> ok, got that in your head?

[22:25] <doos> yes

[22:25] <Frank8> yes

[22:25] <DragonStek> yes

[22:25] <CrystalStar> yep

[22:25] <BrianQ> basically nothing is moving, just sitting there.

[22:25] <BrianQ> Then suddenly a ball in the middle doubles in size...

[22:26] <BrianQ> If it grew in size, then it would press on and compress the springs attached to it, yes?

[22:26] <CrystalStar> yes

[22:26] <doos> ball on top?

[22:26] <BrianQ> Balls and springs in a line, horizontal or vertical, however you want Doos

[22:27] <BrianQ> So... the springs would then press on the other balls attached to them...

[22:27] <BrianQ> and they'd tell their friends, and they'd tell their friends, and so on...

[22:28] <BrianQ> so suddenly all the balls and springs are in motion.

[22:28] <BrianQ> Just from this one ball doubling its size

[22:28] <BrianQ> This is a classical analogy of what happens in molecules or solids... the balls being the atoms

[22:29] <BrianQ> and the springs representing the forces keeping the atoms together in a certain arrangement

[22:29] <Frank8> nice clear visual image

[22:29] <doos> yes, good

[22:29] <CrystalStar> yes

[22:29] <BrianQ> when objects move they have kinetic energy... so ...

[22:30] <BrianQ> When an atom in a molecule or crystal is excited by absorbing light, in our analogy it changes its size

[22:30] <BrianQ> This is what sort of happens even in the quantum picture, too. So the analogy is pretty good.

[22:31] <BrianQ> The size change starts all the surrounding guys into motion... so the energy provided by the photon to a single atom is basically dispersed to all the other nearby atoms by setting them in motion

[22:32] <BrianQ> This vibrational motion, translated to the macroscopic scale, is called heat.

[22:32] <BrianQ> So the light energy is converted to heat

[22:32] <Frank8> thanks that's very clear :)

[22:33] <BrianQ> This is another mechanism for causing absorption lines or bands in our spectroscope

[22:34] <BrianQ> This mechanism has to occur in a molecule or crystal, of course.

[22:34] <BrianQ> Now in this case, the atom absorbed the photon and no photon is re-emitted.

[22:34] <BrianQ> in this mechanism, so to speak

[22:36] <BrianQ> Recall that to excite an atom you need a certain discrete energy to create one state from the next

[22:37] <BrianQ> an isolated atom, that is

[22:37] <BrianQ> But in a molecule or crystal, the energy needed to excite one state is not so discrete... it tends to broaden out and cover a small range of wavelengths

[22:38] <@Spauwe> hence the absorption bands instead of lines

[22:38] <@Spauwe> I was waiting to ask that

[22:38] <BrianQ> yes, exactly, and the reason why is that atoms are not fixed in place with respect to each other.

[22:39] <BrianQ> If the separation between atoms in a hydrogen MOLECULE changes slightly, then the energy needed to excited the atoms changes slightly

[22:40] <BrianQ> And since then atoms are never still with respect to each other, this is what causes the broadening from atomic lines to molecular bands

[22:40] <@Spauwe> ok yep

[22:40] <Frank8> so liquid hydrogen would require different energy levels than gaseous hydrogen to shift states?

[22:41] <@Spauwe> and this will lead to green being seen with an Fe²⁺ in peridot and red in almandine, different neighbours

[22:41] <BrianQ> gaseous hydrogen can still be molecular...

[22:41] <BrianQ> i.e., H₂ molecule

[22:41] <Frank8> yes but the atoms would still be further apart than in liquid wouldn't they?

[22:43] <BrianQ> mm... probably they are close enough in liquid to collide with each other, so perhaps the energy range would BROADEN a bit, but it isn't like it is a completely different energy for excitation

[22:43] <Frank8> ok ty

[22:43] <BrianQ> Actually, this is the principle in high-pressure sodium lamps

[22:44] <BrianQ> in low pressure sodium lamps, you have basically isolated atoms of sodium, so you get clear atomic lines in your spectrum

[22:44] <BrianQ> Thus the lamps other name, spectral sodium lamp.

[22:44] <BrianQ> But high-pressure sodium lamps, the sodium atoms are colliding very often, so the spectral emission lines get broadened out.

[22:45] <BrianQ> And these lamps are used for street lights so that you aren't seeing just exactly one color of yellow.

[22:45] <BrianQ> But it is still primarily a yellow light

[22:45] <BrianQ> Did that make sense?

[22:45] <@Spauwe> are they?\

[22:45] <@Spauwe> now you tell us

[22:45] <Frank8> yes

[22:45] <doos> yes it does

[22:45] <DragonStek> yes

[22:45] <@Spauwe> I'm out pulling one off

[22:46] <BrianQ> use your spectroscope on it!

<BrianQ> ok... so now how do we get fluorescence....

[22:47] <BrianQ> Well let's recall the case of the excitation of hydrogen atom from $n=1$ to $n=3$...

[22:47] <doos> make molecules and apply energy to them

[22:48] <BrianQ> A similar thing can happen to an atom in a crystal... go to a higher excited state, say one that requires blue light to excite

[22:49] <BrianQ> Some of that energy is lost to the vibration of other nearby atoms, so the excited atom deflates to an "intermediate" state, which is still above the ground state

[22:50] <BrianQ> Then the "intermediate" state, also called a "metastable state", doesn't release any more energy to vibrate other atoms...

[22:50] <BrianQ> instead it releases the energy as a photon with longer wavelength than what went in to excite the atom

[22:50] <BrianQ> that is fluorescence.

[22:50] <doos> ty

—————01[22:51] <@Spauwe> kewl

[22:51] <DragonStek> oh cool ty

[22:51] <CrystalStar> wow

[22:51] <BrianQ> So Frank, does that answer what happens to the excess energy in fluorescence?

[22:51] <Frank8> yes indeed

[22:51] <Frank8> I knew it was used up as heat but I wanted to know why, how, what etc...thanks

[22:51] <BrianQ> The energy loss to the nearby atoms is called "relaxation" or "radiationless transition".

[22:52] <BrianQ> So the process is: excitation, relaxation, emission.

[22:52] <Frank8> sounds coital

[22:52] <BrianQ> indeed!

[22:52] <@Spauwe> ghehe

[22:52] <doos> been reading the dictionary again Frank?

[22:53] <CrystalStar> reverse the last two and you can do this in bed :p

[22:53] <@Spauwe> relaxation coming after emission

[22:53] <BrianQ> except I think the last two terms should be reversed for Frank's biology

[22:53] <Frank8> just cause you think lemonade is a big word Doos

[22:53] <BrianQ> yes, Crystal!

[22:53] <DragonStek> lol

[22:53] <BrianQ> and Tim!

[22:54] <DragonStek> lol

[22:55] <BrianQ> Ok, so I have an interesting problem I ran into with my ruby laser rod, if y'all have time

[22:55] <CrystalStar> yes, of course Brian

[22:55] <doos> yes Brian

[22:55] <CrystalStar> lol

[22:55] <BrianQ> ok, here we go.. the rod is a cylinder about 1 cm in diameter and 10 cm in length.

[22:57] <BrianQ> ok, so I stick the spectrometer at one circular face, and I shine white light into the SIDE!

[22:58] <Frank8> so the light is perpendicular to the spectrometer

[22:58] <BrianQ> ok, so I do this experiment and I get a beautiful spectrum showing two very tall fluorescent peaks very close together around 690 nm, yets

[22:58] <BrianQ> I mean, yes

[22:58] <doos> yes

[22:59] <Frank8> yes this is normal

[22:59] <Frank8> for ruby

[22:59] <BrianQ> Ideal spectrum... no blue or green light, just a background of red light with two very very tall peaks

[22:59] <BrianQ> yes, exactly what we expect for ruby

[22:59] <Frank8> synthetic ruby

[23:00] <BrianQ> Now... instead, I shine the white light straight down the face toward the spectrometer

[23:00] <BrianQ> and the spectrum shows...

[23:00] <BrianQ> no blue (or violet, of course)

[23:00] <BrianQ> no green

[23:00] <BrianQ> a red non-zero background relatively flat

[23:00] <BrianQ> with...

[23:01] <@Spauwe> 2 emission lines

[23:01] <BrianQ> two very deep absorption lines at around 690 nm

[23:01] <doos> so the opposite

[23:01] <@Spauwe> ai

[23:01] <BrianQ> Not something you typically see in ruby.

[23:01] <BrianQ> yes, the opposite

[23:01] <BrianQ> What happened?

[23:02] <@Spauwe> I had it wrong

[23:02] <doos> in the last case the spectrometer is at the opposite face?

[23:02] <@Spauwe> thinking the emission would be in all directions so in this direction as well

[23:02] <doos> spectrometer*

[23:02] <BrianQ> yes, at the opposite face

[23:02] <Frank8> sometimes I can get the lines to wink from emission to absorption lines through the spectroscope just by moving the stone slightly

[23:02] <BrianQ> whereas in the first case the light was coming from the side

[23:02] <@Spauwe> ok yep I see

[23:03] <doos> isn't that a logical consequence?

[23:03] <BrianQ> mm, maybe there is a reason for that Frank, maybe we can figure it out.

[23:03] <BrianQ> So... please do explain Doos ;)

[23:03] <doos> if it emits in one direction, chances are it will be absorbed in another

[23:03] <Frank8> are we looking at E rays then at O rays?

[23:03] <doos> the first case being a random direction

[23:04] <BrianQ> not quite... the Cr ion is rather uniform in its preferences

[23:04] <BrianQ> but maybe a core of truth there, Doos...

[23:04] <doos> isn't this similar to the rubidium experiment?

[23:04] <BrianQ> The first arrangement is very much like the Rb experiment.

[23:05] <@Spauwe> question:

[23:05] <BrianQ> With the camera replaced by the spectrometer

[23:05] <BrianQ> yes, Spauwe

[23:05] <@Spauwe> since the emission will be in random directions it'll be in the direction of the incoming light as well wont it

[23:05] <BrianQ> and the second arrangement is very much like the Rb experiment with the detector replaced by the spectrometer

[23:05] <@Spauwe> in the way it was travelling I mean

[23:06] <doos> maybe I am missing that we are talking molecules now and that the bal-springs have different "tensions" in different directions

[23:06] <BrianQ> some will proceed along that direction, but most is re-emitted in other directions, since it is random

[23:06] <BrianQ> So Doos explanation is actually pretty good.

[23:06] <@Spauwe> but no emission line in the middle of a bit wider absorption line?

[23:07] <Frank8> ruby can fluoresce under visible light so the fluorescent lines are caused by fluorescence

[23:07] <BrianQ> nope, no emission line in the middle of a wider absorption... in fact, the absorption lines look exactly like the fluorescent lines turned upside down

[23:08] <BrianQ> I think Doos explanation is partially correct, but there is an additional consequence we haven't considered.

[23:08] <Frank8> but why they dont fluoresce under light from all directions and choose instead to absorb light then is it the crystal structures atomic bonding and trigonal bonds that cause the difference

[23:08] <BrianQ> oh, your making my head spin, Frank :)

[23:08] <BrianQ> too many big words

[23:08] <Frank8> and mine

[23:08] <BrianQ> ok, let's concentrate on creating that metastable state, ok?

[23:09] <BrianQ> There are really two routes that we could create it, can anybody name one?

[23:10] <@Spauwe> firing high freq light at it

[23:10] <Frank8> UV light

[23:10] <BrianQ> yes, yes

[23:10] <@Spauwe> heating it

[23:10] <Frank8> and visible light

[23:10] <BrianQ> except Frank, my white light source doesn't have UV

[23:10] <BrianQ> no, not heating it

[23:10] <@Spauwe> it'll glow though

[23:10] <BrianQ> unless you go up to 600 C, and I'm not going to do that

[23:10] <doos> heh

[23:10] <BrianQ> yes

[23:10] <BrianQ> it will glow

[23:11] <BrianQ> now shining the light through the side, the light traverses about a 1 cm distance...

[23:11] <BrianQ> and in that distance all the green and blue light is absorbed, and some of that is used to create the fluorescent state

[23:12] <BrianQ> which then emits red fluorescent light to produce the observed peaks, yes?

[23:12] <Frank8> yes

[23:12] <doos> yes

[23:12] <BrianQ> and how do we know the green and blue light is absorbed?

[23:12] <BrianQ> we have flat zero across those wavelengths

[23:12] <doos> by the zero transmission

[23:12] <BrianQ> yes?

[23:12] <BrianQ> yes

[23:13] <BrianQ> now we shine the light down from the face, yes...

[23:13] <BrianQ> and the light can travel a distance of around 10 cm down the rod.

[23:13] <BrianQ> The green and blue light are lost in what distance?

[23:14] <Frank8> 1cm

[23:14] <doos> 1cm

[23:14] <BrianQ> yes, so no green or blue light for the next 9 cm....

[23:14] <@Spauwe> aaah

[23:14] <@Spauwe> I see

[23:14] <Frank8> so only red light reaches the spectroscope...so no fluorescence

[23:15] <BrianQ> so what does the Cr ion want to do... it still wants to create that metastable state.

[23:15] <Frank8> sorry no emission lines

[23:15] <@Spauwe> viewed from the side that'll be cool

[23:15] <BrianQ> but it has no green or blue light to do it.

[23:15] <Frank8> it absorbs what energy it can from the red light

[23:15] <BrianQ> It still wants that metastable state, but it has no green or blue light, so what is the other path to create that metastable state?

[23:16] <BrianQ> yes, Frank has pinpointed it...

[23:16] <doos> absorption

[23:16] <@Spauwe> ok

[23:16] <BrianQ> It makes a direct transition from ground to the metastable state by exactly absorbing the red light needed

[23:17] <BrianQ> and it does this all along the 9 cm left...

[23:17] <@Spauwe> will you observe a difference in fluorescence though between the first cm and the rest?

[23:17] <BrianQ> I think so, actually!

[23:18] <BrianQ> You'd see the peak through a 1 cm length that would decrease and turn into an absorption as the length increases

[23:18] <doos> and the absorbed red light relaxes to heat?

[23:18] <BrianQ> no... the absorbed red light emits again, so that the metastable returns to ground...

[23:19] <BrianQ> but the emitted light is not in the same direction as the original light traveling toward the spectrometer

[23:19] <doos> oh yes

[23:19] <doos> forgot about that part

[23:19] <doos> makes sense

[23:19] <BrianQ> As we first discussed... the emitted light can be in any direction, yes

[23:19] <doos> yes

[23:19] <doos> heh full circle

[23:19] <CrystalStar> yes

[23:20] <BrianQ> So... that is what I think is happening, but it sure was a surprise when I first saw it happen

[23:20] <BrianQ> And what made me think about it is this....

[23:20] <doos> nice going again Brian .. very clever

[23:20] <DragonStek> wow interesting

[23:20] <Frank8> I wonder how thin a slice you'd need as a minimum to use up all the blue and green light

[23:20] <@Spauwe> not much

[23:21] <BrianQ> Good question Frank, I think that 1 cm definitely uses up all the green and blue, so something smaller than that

[23:21] <doos> a few micrometer

[23:21] <@Spauwe> a small ruby will do it (according to my spectroscope)

[23:21] <BrianQ> yes, in fact, I forgot... Frank's synthetic ruby shows no green or blue, and it is not very thick

[23:22] <@Spauwe> wouldn't that be visible from the side when looking at that rod?

[23:22] <BrianQ> Here's the thing... the rod is designed to accept light from the side... much larger surface area than the circular face.

[23:23] <@Spauwe> no I mean in your set-up

[23:23] <@Spauwe> light going through the length

[23:23] <@Spauwe> you're eye viewing the side

[23:23] <Frank8> wouldn't it all just look red Spauwe?

[23:24] <BrianQ> No, the spectrometer doesn't really see the light from the source going through the side

[23:24] <@Spauwe> a bright fluorescent first bit and less the rest

[23:24] <Frank8> whether the red is caused by fluorescence or absorption it will all look red to the eye

[23:24] <BrianQ> Just as Doos was first pointing out, in that arrangement spectrometer at end, light directed through the side,

[23:24] <@Spauwe> but maybe not as bright since there's less energy involved?

[23:25] <@Spauwe> ow, the light is through the side as well

[23:25] <BrianQ> is like the Rb experiment with spectrometer positioned where the camera was.

[23:25] <@Spauwe> yep

[23:25] <@Spauwe> new experiment

[23:25] <@Spauwe> no spectrometer

23:25] <@Spauwe> and the light directed through the length

3:25] <Frank8> if you sent the light through the circular end but set up the specrometer at the side you could move it gradually towards the light source and pinpoint where the absorption turns to emission

[23:26] <@Spauwe> something like that would probably be more accurate yes

23:26] <BrianQ> A good idea Frank, except that arrangement will only show the fluorescence...

[23:27] <BrianQ> since only fluorescence can be seen perpendicular to the beam direction

[23:27] <Frank8> ah yes

[23:27] <doos> guys .. I need sleep .. sorry to be rude

[23:27] <DragonStek> night doos

[23:27] <doos> thanks again Brian, good teaching

[23:27] <@Spauwe> slaap lekker

[23:27] <Frank8> bye doos

[23:27] <BrianQ> ok doos, maybe Spauwe will include this last bit how I linked it to the emerald spectrum

[23:27] <CrystalStar> thanks brian, g'night Doos

[23:27] <doos> night night

[23:27] * doos (n=doos@cp59312-b.tilbu1.nb.home.nl) Quit ("Leaving")

[23:28] <BrianQ> The last bit, eh?

[23:28] <BrianQ> or next time?

[23:28] <@Spauwe> I'm here now

[23:28] <Frank8> last bit

3:28] <BrianQ> heheh, ok

[23:28] <Frank8> dozy doos can read it later

[23:28] <BrianQ> Now emerald has the Cr ion, and the Cr ion there also has the metastable state.

[23:29] <BrianQ> When you look at emerald, how does the metastable state show up in its spectrum?

[23:29] <@Spauwe> 3 seperate bands

[23:29] <Frank8> same lines in deep red

[23:29] <@Spauwe> sharp to fuzzy

[23:29] <BrianQ> absorption or emission?

[23:29] <@Spauwe> absorption

23:30] <BrianQ> yes, in emerald it shows up as absorption... and why?

[23:30] <BrianQ> that is, why is it a peak in ruby, but a dip in emerald?

[23:30] <Frank8> no fluorescence from visible light...you need uv

[23:30] <@Spauwe> different neighbouring atoms?

3:31] <BrianQ> Yes... Spauwe and Frank..

[23:31] <BrianQ> The emerald doesn't absorb green (obviously!!) that can then relax to the metastable state

[23:32] <BrianQ> so the ONLY path in emerald to the metastable is the direct path from ground... absorb the red light.

[23:32] <@Spauwe> yep, get that now

23:32] <BrianQ> Whereas the ruby has the excitation, relaxation path and a whole lot of green and blue light to go along that path

[23:33] <BrianQ> But if you subtract out all the green and blue... the ruby spectrum in red starts to look just like the emerald spectrum in red...

[23:33] <BrianQ> as I found with the ruby rod!

[23:33] <BrianQ> crazy, eh?

[23:34] <DragonStek> wow interesting

[23:34] <CrystalStar> pretty cool!

[23:34] <@Spauwe> I read that a lot but have trouble seeing the similarities

[23:34] <BrianQ> Maybe I should title this talk... how to turn ruby into emerald

[23:34] <CrystalStar> heh

[23:34] <DragonStek> hehe

[23:34] <BrianQ> spectroscopically, at least :)

[23:34] <Frank8> what about the natural rubies...are you seeing smaller absorption dips in the blue?

[23:34] <DragonStek> that so cool

[23:35] <@Spauwe> yep

[23:35] <@Spauwe> a couple of fine lines and most of the violet

[23:35] <BrianQ> in natural ruby, there is definitely always blue to violet light transmitted, but the green is always gone

[23:36] <BrianQ> I don't know if there is any fine lines in violet, but maybe some due to iron...

[23:36] <Frank8> yes the band across the green in ruby is much wider than the band in emerald which is more over the yellow orange

[23:36] <BrianQ> I haven't done high-resolution spectra of the natural ruby, because my rough is much less transparent than the synthetics

[23:37] <@Spauwe> needing a faceted one?

[23:37] <Frank8> have you tried to polish them on two parallel sides to help the transmission of light?

[23:37] <BrianQ> oh, the emerald is highly transparent to the blue green and only teeny tiny absorption in the yellow

[23:37] <BrianQ> This is what needs to be done with them, Frank, exactly.

[23:38] <Frank8> ask john (jleb) to do a couple for you...you can send them to him

[23:38] <BrianQ> Yep, Spauwe... not so much faceting as two polished parallel sides.

[23:38] <@Spauwe> PM me your details Brian and I'll sort you out

[23:38] <Frank8> ha yes I forgot that spauwe has a lap

[23:38] <BrianQ> in fact, I have to be wary of faceting on Frank's synthetic...

[23:39] <Frank8> grind the bugger parallel then

[23:39] <BrianQ> Have to turn the table toward the spectrometer, away from the source...

[23:39] <BrianQ> anyone know why?

[23:39] <@Spauwe> reflection

[23:39] <Frank8> TIR

[23:39] <DragonStek> so the rough shows better spectrum than faceted ?

[23:40] <BrianQ> yes, exactly... light entering the table is meant to leave through the table... the whole point of faceted gems

[23:40] <Frank8> though not exactly as the stone isn't cut for it but light shone in the table should in theory come back out the top

23:40] <@Spauwe> nope but the total internal reflection sends all the light back to the source

[23:40] <@Spauwe> IF it's cut properly

[23:40] <Frank8> for the RI of the stone each angle is different

[23:41] <@Spauwe> jleb's brilliancy chat remember

[23:41] <BrianQ> Yep, but you can shine the light through the "bottom" of the gem and it isn't totally internally reflected from the table, and so you get a very nice spectrum that way

[23:41] <DragonStek> ok got yah

[23:42] <BrianQ> Whereas you shine the light through the table, and it is reflected from the botton, and so you get no spectrum

[23:42] <BrianQ> oops, wife is hollerin', gotta go!!!!!!!

[23:42] <BrianQ> it was a long one today.

[23:42] <@Spauwe> cheers

23:42] <DragonStek> oh great chat thanks

[23:42] <BrianQ> ciao ciao everyone

[23:42] <Frank8> bye Brian great chat

02[23:42] * BrianQ (n=fn-javac@adsl-230-14-242.hsv.bellsouth.net)
Quit ("Java user signed off")