Chapter 1 : The Zeeman Effect

The Zeeman effect (/ Ëˆ z eÉª m É™n /; Dutch pronunciation:), named after the Dutch physicist Pieter Zeeman, is the effect of splitting a spectral line into several components in the presence of a static magnetic field.

For the red Cd line and a typical mirror separation of mm the intensity as a function of and for two values of reflectivities is shown in Fig. Angular distribution of the transmitted intensity of the red Cadmium line. The two sets of lines correspond to two wavelengths with. You can clearly see that the larger reflectivity leads to a better separation of the two wavelengths. A Cadmium lamp is placed between the poles of an electromagnet. Light emitted by th lamp passes through a Fabry-Pero FP etalon. A red filter is used to isolate the red Cadmium line. The circular fringes produced at infinity by constructive interference are imaged as circular rings in the focal plane of the telecopy lens. This intermediate image can either be viewed using an eyepiece or it is viewed by a CCD camera. In order to be able to take and analyze data you need to perform the following tasks: Schematic of the experimental setup. Determine the magnetic field at the location of the lamp for a given coil current. The FP-etalon is extremely sensitive. You can easily see small vibrations of the table. Calibrate the CCD camera. Turn on the cooling water supply for the electromagnet. Switch on the magnet power supply and gradually increase the current to Use the gauss-meter to measure the magnetic induction, B T , halfway between the poles. The correct value is the maximum value, obtained when the plane of the probe is held perpendicularly to the field. Decrease the current to zero and switch off the power supply. Replace the cadmium lamp, being careful not to alter the gap between the poles, and switch the lamp on 0. The Cadmium lamp takes about 5 - 10 min to fully warm up. Without the red filter or telescope in place, turn the adjusting screws on the nearer partially reflecting plate until circular fringes are seen. You can also use the large micrometer screw to adjust the overall distance between the plates. Make only small correction and try to obtain the sharpest fringes possible. Replace the telescope objective. Look into the telescope without camera or eyepiece and make sure you still see the fringes. Make more adjustments to get the best result. Align the camera with the telescope and the lamp. Start the camera control program on the computer and open a life view with about 10 frames per second. The distance between the end of the telescope lens and the camera lens should be about 11 cm. Adjust the focus of the camera to get a sharp image of the fringes. Every time you adjust the alignment you should also adjust the focusing. Once you have the sharpest fringes you can carefully place the red filter on the telescope lens. Try to further optimize the sharpness the red fringes. In the end they should look like those in Fig. Fringes with red filter of the red Cadmium line without magnetic field. Take a picture of your sharp fringes and save it to disk. Now you are ready to turn on the magnetic field. Once you reach 10A you should see that each fringe has spit up in several fringes as an example see Fig. You can still try to optimize the sharpness of the fringes. Once you have a good picture take snap-shots with the camera. You will see that the quality of the images continually changes slightly. Once you have taken a few good images turn off the magnetic field. Fringes with magnetic field. Take the small caliper and place it before the camera such that you see a sharp image. Now you have your calibration and you are ready to analyze the images. A typical calibration picture us shown in Fig. Picture of a ruler to calibrate the camera. From the splitting of the lines, determine and therefore and with the the knowledge of you can determine.

Chapter 2 : Zeeman effect | Define Zeeman effect at www.nxgvision.com

normal zeeman effect in Science Zeeman effect The splitting of single spectral lines of an emission or absorption spectrum of a substance into three or more components when the substance is placed in a magnetic field.

What is the Zeeman effect? Wong Answer The Zeeman effect is the splitting of a spectral line by a magnetic field. That is, if an atomic spectral line of nm was considered under normal conditions, in a strong magnetic field, because of the Zeeman effect, the spectral line would be split to yield a more energetic line and a less energetic line, in addition to the original line at nm. The reason for the Zeeman effect is that in a magnetic field, the angular momentum quantum state can undergo a displacement from degeneracy. For example, the p orbital has three possible angular momentum quantum states that are degenerate of the same energy under normal circumstances. However, each angular momentum quantum state has a magnetic dipole moment associated with it, so the effect of a magnetic field is to separate the three states into three different energy levels. One state elevates in energy, one lowers in energy, and one remains at the same energy. The separation of these quantum states into three different energy levels results in 3 different excitation states with slightly different energies that give rise to three spectral lines of slightly different energy one of the same energy as the original spectral line, one more energetic, and one less energetic upon relaxation of the atom. This is the simplist case of the Zeeman effect, known as the Normal Zeeman effect. Jay Foley, Undergraduate Chemistry Student, Georgia Tech In a magnetic field the energy of a particular atomic stat depends on the value of m ,magnetic quantum number,. A state of total quantum number n breaks up into several substates when the atom is in the magnetic field ,and their energies are slightly more or slightly less than the energy of state in the absence of magnetic field. This phenomenon leads to "splitting" of individual spectral lines when atoms radiate in a magnetic field. The spacing of the lines depends on the magnitude of the field. The Zeeman effect is a vivid confirmation of space quantisation. The effect is due to the distortion of the electron orbitals because of the magnetic field. The normal Zeeman effect can be understood classically, as Lorentz predicted. Zeeman discovered the effect, but under closer investigation it did not agree with Lorentz. These differences were explained by the quantum mechanics effects of spin. This is the anomalous Zeeman effect. In fact, it was the anomalous Zeeman effect that led to the discovery of spin. Any book on quantum mechanics will deal with the Zeeman effect. The usual method is to use perturbation theory, the details depend on the strength of the magnetic field. Consider the hydrogen atom. The full Hamiltonian H is split up into 3 pieces. To first-order the relativistic terms led to the fine-structure energy shift. If the magnetic field is weak compared to the relativistic corrections then the Zeeman term can be considered a perturbation of the relativistic terms. If the magnetic field is strong then we can diagonalize the coulomb and Zeeman terms and then consider the relativistic correction as a perturbation. This is the Paschen-Back Effect. For arbitrary magnetic fields degenerate perturbation theory is needed. For arbitrary atoms it becomes difficult, but the same ideas apply. A very similar effect is the Stark effect in which the atom is placed inside a strong electric field. Again, perturbation theory is the usual approach.

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Chapter 3 : Normal Zeeman effect

The normal Zeeman effect is exhibited in transitions between states characterized by a total spin of zero, where the magnetic moment is solely due to the orbital motion of the electrons.

It is one of three types of Zeeman effect. This effect can be observed in the absence of electron spins. When energy is given to an atom, the atom gains an excited state. The electrons of that atom can absorb energy and move to a higher energy level. Likewise, all electrons of that atom can absorb energy and move to higher energy levels. This gives us the absorption spectrum of that atom. Each spectral line indicates the energy difference between the energy levels that the electron moved through. The spectrum given in the normal condition is different from the spectrum given when the atom is placed in a magnetic field. It shows more spectral lines due to splitting. The normal Zeeman effect can be observed for zero spin states. In zero spin state, the electron spin does not contribute to angular momentum. There the single spectral line has been split into three lines with equal spaces between them. What is Anomalous Zeeman Effect Anomalous Zeeman Effect is the splitting of spectral lines of an atomic spectrum caused by the interaction between magnetic field, the combined orbital and intrinsic magnetic moment. This effect can be observed as a complex splitting of spectral lines. In some atoms, there are complex splitting patterns rather than triplet formations. This is the anomalous Zeeman effect. Here, the spectral lines are split into four lines, six lines, etc. Sometimes the spaces between the spectral lines are wider than expected. This happens due to the effects of electron spin. Since the spin of electrons contributes to the angular momentum, splitting becomes more complicated. Zeeman effect at Different Strengths of Magnetic Field Moreover, the applied magnetic field has an effect on the splitting pattern of spectral lines. In weak fields, the splitting is much more similar to the normal Zeeman effect. But with the increased magnetic field, the splitting patterns also vary. Normal Zeeman Effect is the splitting of spectral lines of an atomic spectrum due to the interaction between the external magnetic field and the orbital magnetic moment. Anomalous Zeeman Effect is the splitting of spectral lines of an atomic spectrum that is caused by the interaction between the magnetic field and the combined orbital and intrinsic magnetic momentum. Electron Spin Normal Zeeman Effect: Normal Zeeman effect is observed at zero electron spin states. The anomalous Zeeman effect is observed in the presence of an electron spin. Splitting Pattern Normal Zeeman Effect: In normal Zeeman effect, one spectral line is split into a triplet. In anomalous Zeeman effect, one spectral line is split into different complicated patterns. Magnetic Moment Normal Zeeman Effect: Normal Zeeman effect occurs due to the presence of orbital magnetic momentum. Anomalous Zeeman effect occurs due to the presence of both orbital and intrinsic magnetic moment. Conclusion The phenomena of Zeeman effect describes the behavior of an atom in the presence of an external magnetic field. This Zeeman effect can be observed in two types as normal Zeeman effect and anomalous Zeeman effect. The main difference between normal and anomalous Zeeman effect is that normal Zeeman effect results in the formation of triplets by splitting a spectral line into three lines whereas anomalous Zeeman effect results in different splitting patterns from the splitting of spectral lines. Her interest areas for writing and research include Biochemistry and Environmental Chemistry.

Chapter 4 : Zeeman effect - Wikipedia

"Normal" Zeeman effect This type of splitting is observed with hydrogen and the zinc singlet. This type of splitting is observed for spin 0 states since the spin does not contribute to the angular momentum.

Chapter 5 : Anomalous Zeeman effect

Normal Zeeman effect In an experiment performed by the Dutch physicist Peter Zeeman in , it was observed that each spectral line in the excitation spectrum for an atom placed in a magnetic field split into number of additional lines.

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Chapter 6 : 1: Normal Zeeman Effect - Chemistry LibreTexts

H.A. Lorentz successfully interpreted the normal Zeeman Effect by using the laws of classical physics. He assumed that the motion of electron in atom is harmonic. Since the electron is revolving (say with angular velocity) around the nucleus in an orbit of radius, the restoring force is centrifugal force.

Chapter 7 : Normal Zeeman Effect â€” Modern Lab Experiments documentation

In normal Zeeman effect, the line is split into three lines, whereas in anomalous Zeeman effect, the splitting is more complex. This is the key difference between normal and anomalous Zeeman effect. CONTENTS.

Chapter 8 : Zeeman Effect | apni Physics

Normal Zeeman effect explained in a simple way by Lorentz by using the Bohr's atomic model. The complete description of this theory you can watch through this video discussed in Hindi and English. The classical theory of Zeeman Effect Part

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Zeeman effect, splitting of a single spectral line (see spectrum) into a group of closely spaced lines when the substance producing the single line is subjected to a uniform magnetic field. The effect was discovered in by the Dutch physicist Pieter Zeeman. In the so-called normal Zeeman effect.