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Absorption spectrum definition in simple words

Also found in: Thesaurus, Medical, Encyclopedia, Wikipedia. N. The electromagnetic spectrum, broken by a specific pattern of dark lines or bands, observed when radiation passes through a particular absorbent medium and through a spectroscope. The absorption pattern of an element is unique and can be used to identify the substance of the medium. American Heritage® Dictionary of the English Language, Fifth Edition. Copyright © 2016 by Houghton Mifflin Harcourt Publishing Company. Published by Houghton Mifflin Harcourt Publishing Company. All rights reserved. n (General Physics) the characteristic pattern of dark lines or bands that occurs when electromagnetic radiation is passed through an absorbent medium in a spectroscope. An equivalent pattern occurs as colored lines or bands in the emission spectrum of this medium Collins English Dictionary – Complete and Unabridged, 12th Edition 2014 © HarperCollins Publishers 1991, 1994, 1998, 2000, 2003, 2006, 2007, 2009, 2011, 2014 n. The spectrum formed by electromagnetic radiation that passed through a medium in which radiation from certain frequencies is absorbed. Random House Kernerman Webster's College Dictionary, © 2010 K Dictionaries Ltd. Copyright 2005, 1997, 1991 by Random House, Inc. All rights reserved. The pattern of dark lines and colors made when light passes through an absorbent medium, such as a gas or liquid. The dark lines represent the colors that are absorbed. Because each type of atom absorbs a unique range of colors, the absorption spectrum can be used to identify the composition of distant substances, such as the gaseous outer layers of stars. The Dictionary of Student Science ® American Heritage, Second Edition. Copyright © 2014 by Houghton Mifflin Harcourt Publishing Company. Published by Houghton Mifflin Harcourt Publishing Company. All rights reserved. Absorption spectrum noun1.- the spectrum of electromagnetic radiation that passed through a medium that absorbed radiation from certain wavelengths - an ordered array of the components of an emission or waveBaçada in WordNet 3.0, farlex clipart collection. © Princeton University 2003-2012, Farlex Inc. Want to thank TFD for its existence? Tell a friend about us, add a link to this page, or visit the webmaster page for free fun content. Link to this page: absorption spectrum Todorov); International Business Machines Corporation has patented a method that involves selecting a combination of multiple organic materials to incorporate into a sunscreen composition, on which the selection is based, at least in part: a desired absorption spectrum of the sunscreen composition; the absorption spectrum of each of the multiple organic materials, and; particle size limitation for each of the multiple organic materials. Settings absorption spectrum 1 Type of: spectrum an ordered matrix of the components of an emission or wave An overview of electromagnetic electromagnetic radiation This example discusses the general principle using visible light. A white beam source – emitting light of multiple wavelengths – is focused on a sample (complementary color pairs are indicated by yellow dotted lines). Upon reaching the sample, photons that correspond to the energy gap of the molecules present (green light in this example) are absorbed to excite the molecule. Other photons transmit unaffected and, if the radiation is in the visible region (400-700 nm), the color of the sample is the complementary color of the absorbed light. By comparing the attenuation of transmitted light with the incident, an absorption spectrum can be obtained. The first direct detection and chemical analysis of an exoplanet's atmosphere in 2001. Sodium in the atmosphere filters the starlight of HD 209458 as the giant planet passes in front of the star. Absorption spectroscopy refers to spectroscopic techniques that measure radiation absorption, as a function of frequency or wavelength, due to their interaction with a sample. The sample absorbs energy, i.e. photons, from the irradiation field. The intensity of absorption varies as a function of frequency, and this variation is the absorption spectrum. Absorption spectroscopy is performed throughout the electromagnetic spectrum. Absorption spectroscopy is used as an analytical chemistry tool to determine the presence of a particular substance in a sample and, in many cases, quantify the amount of the substance present. Infrared and ultraviolet-visible spectroscopy are particularly common in analytical applications. Absorption spectroscopy is also used in molecular and atomic physics studies, astronomical spectroscopy, and remote sensing. There are a wide range of experimental approaches to measuring absorption spectra. The most common arrangement is to direct a beam of radiation generated in a sample and detect the intensity of the radiation passing through it. Transmitted energy can be used to calculate absorption. The source, sampling arrangement and detection technique vary significantly depending on the frequency range and purpose of the experiment. The following are the main types of absorption spectroscopy:[1] Mr. No Electromagnetic Radiation Spectroscopic Type 1 X-ray absorption spectroscopy 2 Ultraviolet-visible SPECTROSCOPY UV-vis absorption spectrum Spectroscopy 3 Infrared IR absorption spectroscopy 4 Microwave absorption spectroscopy 5 Radio Wave Spectroscopy Electronic rotation spectroscopy Magnetic resonance spectroscopy with Fraunhofer lines as visual. The absorption spectrum of a material is the fraction of incident radiation absorbed by the material over a series of frequencies. The absorption spectrum is mainly determined by the atomic and molecular composition of the material. Radiation is more likely to be absorbed at frequencies corresponding to the energy between two quantum mechanical states of de de Molecules. The absorption that occurs due to a transition between two states is referred to as an absorption line and a spectrum is typically composed of many lines. The frequencies where the absorption lines occur, as well as their relative intensities, depend mainly on the electronic and molecular structure of the sample. Frequencies will also depend on the interactions between molecules in the sample, the crystalline structure in solids, and various environmental factors (e.g., temperature, pressure, electromagnetic field). The lines will also have a width and shape that are determined primarily by the spectral density or density of the system states. Theory Absorption lines are typically classified by the nature of quantum mechanical change induced in molecule or atom. Rotational lines, for example, occur when the rotational state of a molecule changes. Rotational lines are typically found in the spectral region of the microwave. Vibrational lines correspond to changes in the vibrational state of the molecule and are typically found in the infrared region. Electronic lines correspond to a change in the electronic state of an atom or molecule and are typically found in the visible and ultraviolet region. X-ray absorptions are associated with the excitation of electrons from internal shells into atoms. These changes can also be combined (e.g., rotation-vibration transitions), leading to new absorption lines in the combined energy of the two changes. The energy associated with quantum mechanical change mainly determines the frequency of the absorption line, but the frequency can be displaced by various types of interactions. Electrical and magnetic fields can cause a change. Interactions with neighboring molecules can cause changes. For example, the absorption lines of the gas phase molecule can change significantly when that molecule is in a liquid or solid phase and interacting more strongly with neighboring molecules. The width and shape of the absorption lines are determined by the instrument used for observation, the material that absorbs the radiation and the physical environment of that material. It is common for lines to be shaped like a Gaussian or Lorentzian distribution. It is also common for a line to be described only by its intensity and width, rather than the whole shape being characterized. The integrated intensity — obtained by integrating the area under the absorption line — is proportional to the amount of the absorbent substance present. The intensity is also related to the temperature of the substance and the quantum mechanical interaction between radiation and the absorbent. This interaction is quantified by the transition moment and depends on the particular lower state from the transition, and the upper state to which it is connected. The width of the absorption lines can be determined by the spectrometer used to record it. A spectrometer has an inherent limit to the narrow one line can solve and so the observed width can can to this limit. If the width is greater than the resolution limit, then it is determined primarily by the absorber environment. A liquid or solid absorber, in which neighboring molecules interact strongly with each other, tends to have wider absorption lines than a gas. The increase in temperature or pressure of the absorbent material will also tend to increase the width of the line. It is also common for several neighboring transitions to be close enough to each other that their lines overlap and the resulting overall line is even wider. The relationship with transmission spectrum and absorption spectrum and transmission spectrum represent equivalent information and one can be calculated from the other through a mathematical transformation. A transmission spectrum will have its maximum intensities at wavelengths where absorption is weaker because more light is transmitted through the sample. An absorption spectrum will have its maximum intensities at wavelengths where the absorption is strongest. Relationship with the emission spectrum The spectrum of iron emissions is a process by which a substance releases energy in the form of electromagnetic radiation. Emission can occur at any frequency where absorption can occur, and this allows absorption lines to be determined from an emission spectrum. The emission spectrum will typically have a very different intensity pattern from the absorption spectrum, however, so the two are not equivalent. The absorption spectrum can be calculated from the emission spectrum using Einstein coefficients. Relationship with dispersion and reflection spectra The dispersion and reflection spectra of a material are influenced both by its refraction index and by its absorption spectrum. In an optical context, the absorption spectrum is typically quantified by the extinction coefficient, and the extinction coefficients and index are quantitatively related through the Kramers-Kronig ratio. Therefore, the absorption spectrum can be derived from a spectrum of dispersion or reflection. This usually requires simplifying assumptions or models, and so the derived absorption spectrum is an approximation. Applications NASA's infrared absorption spectrum of laboratory sulfur dioxide ice is compared with the infrared ice absorption spectra on Jupiter's moon, Io credit NASA, Bernard Schmitt, and UKIRT. Absorption spectroscopy is useful in chemical analysis[5] due to its specificity and quantitative nature. The specificity of absorption spectra allows compounds to be distinguished from each other in a mixture, making absorption spectroscopy useful in a wide variety of applications. For example, infrared gas analyzers can be used to identify the presence of pollutants in the air, distinguishing pollutant from nitrogen, oxygen, water and other expected constituents. [6] The it also allows unknown samples to be identified by comparing a measured spectrum with a library of reference spectra. In many cases, it is to determine qualitative information about a sample, even if it is not in a library. Infrared spectra, for example, have characteristic absorption ranges that indicate whether carbon-hydrogen or carbon-oxygen bonds are present. An absorption spectrum may be quantitatively related to the amount of material present using the Beer-Lambert law. Determining the absolute concentration of a compound requires knowledge of the absorption coefficient of the compound. The absorption coefficient for some compounds is available from reference sources, and can also be determined by measuring the spectrum of a calibration standard with a known target concentration. Remote sensing One of the unique advantages of spectroscopy as an analytical technique is that measurements can be made without putting the instrument and sample into contact. Radiation traveling between a sample and an instrument will contain spectral information, so that measurement can be done remotely. The remote spectral sensor is valuable in many situations. For example, measurements can be made in toxic or hazardous environments without putting an operator or instrument at risk. In addition, the sample material does not need to be put in contact with the instrument—preventing possible cross-contamination. Remote spectral measurements present several challenges compared to laboratory measurements. The space between the sample of interest and the instrument may also have spectral absorptions. These absorptions can mask or confuse the sample absorption spectrum. These background interferences may also vary over time. The source of radiation in remote measurements is often an environmental source, such as sunlight or thermal radiation from a hot object, and this makes it necessary to distinguish spectral absorption from changes in the source spectrum. To simplify these challenges, differential optical absorption spectroscopy has gained some popularity because it focuses on differential absorption features and omits broadband absorption, such as aerosol extinction and extinction due to lightning dispersion. This method is applied to terrestrial, airborne and satellite-based measurements. Some terrestrial methods provide the possibility of retrieving profiles of tropospheric and stratospheric tracking gas. Astronomy absorption spectrum observed by the Hubble Space Telescope Astronomical Spectroscopy is a particularly significant type of remote spectral sensing. In this case, objects and samples of interest are so far from Earth that electromagnetic radiation is the only means available to measure them. Astronomical spectra contain spectral absorption and emission information. Absorption spectroscopy has been particularly important in understanding interstellar clouds and determining that some of them contain molecules. Absorption spectroscopy is also in the study of extrasolar planets. The detection of extrasolar planets by the transit method also aswells their absorption and allows the determination of the atmospheric composition of the planet,[7] temperature, pressure and height of the scale, and therefore also allows the determination of the planet's mass. [8] Atomic and molecular physics Theoretical models, mainly quantum mechanical models, allow absorption spectra of atoms and molecules to be related to other physical properties, such as electronic structure, atomic or molecular mass, and molecular geometry. Therefore, absorption spectrum measurements are used to determine these other properties. Microwave spectroscopy, for example, allows the determination of connection lengths and angles with high precision. In addition, spectral measurements can be used to determine the accuracy of theoretical predictions. For example, the lamb change measured in the atomic hydrogen absorption spectrum was not expected to exist at the time it was measured. His discovery stimulated and guided the development of quantum electrodynamics, and lamb change measurements are now used to determine the fine structure constant. Experimental methods Basic approach The simplest approach to absorption spectroscopy is to generate radiation with a source, measure a reference spectrum of this radiation with a detector, and then re-measure the sample spectrum after placing the material of interest between the source and the detector. The two measured spectra can then be combined to determine the absorption spectrum of the material. The sample spectrum alone is not sufficient to determine the absorption spectrum because it will be affected by experimental conditions —the source spectrum, the absorption spectra of other materials between the source and the detector, and the dependent characteristics of the detector wavelength. The reference spectrum will be affected in the same way, however, by these experimental conditions and therefore the combination produces the absorption spectrum of the material alone. A wide variety of radiation sources are employed to cover the electromagnetic spectrum. For spectroscopy, it is generally desirable for a source to cover a wide range of wavelengths in order to measure a wide region of the absorption spectrum. Some sources inherently emit a broad spectrum. Examples of this include globars or other black body sources in infrared, mercury lamps in visible and ultraviolet and X-ray tubes. A new source of broad-spectrum radiation is synchrotron radiation that covers all these spectral regions. Other radiation sources generate a narrow spectrum, but the emission wavelength can be adjusted to cover a spectral range. Examples of this include klystrons in the microwave region and lasers throughout the infrared, visible and ultraviolet region (although not all lasers have incapable wavelengths). The detector used to measure radiation energy will also depend on the range of interest of the wave. Most detectors are sensitive to a fairly wide spectral and the selected sensor will often depend more on the sensitivity and noise requirements of a given measurement. Examples of common detectors in spectroscopy include heterodyne receptors in the microwave, millimeter and infrared wave bolometers, mercury cadmium tellurium and other infrared cooled semiconductor detectors, and photodiodes and photomultiplier tubes in the visible and ultraviolet. If both the source and the detector cover a wide spectral region, then it is also necessary to introduce a means of resolving the wavelength of radiation in order to determine the spectrum. Often a spectrograph is used to spatially separate wavelengths from radiation so that the power at each wavelength can be measured independently. It is also common to employ interferometry to determine the spectrum — Fourier transformation infrared spectroscopy is a widely used implementation of this technique. Two other issues that should be considered in the configuration of an absorption spectroscopy experiment include the optics used to direct radiation and the means of retention or containment of the sampling material (called cuvette or cell). For most UV, visible and NIR measurements, the use of precision quartz cuvettes is required. In both cases, it is important to select materials that have relatively little own absorption in the wavelength range of interest. The absorption of other materials may interfere with or mask the absorption of the sample. For example, in several wavelength ranges it is necessary to measure the sample under vacuum or in a rare gas environment because gases in the atmosphere have interfering absorption characteristics. Specific approaches Astronomical spectroscopy Cavity ring for low spectroscopy (CRDS) Laser absorption spectrometry (LAS) Mössbauer photocouscopy Photocouscopy Photocouscopy Phototouchoscopic mission spectroscopy Photothermal optical microscopy Photothermal spectroscopy Reflectance Reflectance Spectroscopy T incapable of diode laser absorption spectroscopy (TDLAS) fine X-ray absorption structure (XAFS) X-ray absorption near the edge structure (XANES) Total absorption spectroscopy (TAS) See also absorption (optical) DENSITOMETRY HITRAN Infrared gas analyzerCopy of metal carbonyls Lyman-alpha forest Spectroscopy Optical Spectroscopy photoemissiona transparent materials Water absorption White cell (spectroscopy) X-ray spectroscopy References ^ Kumar , Pranav (2018). Fundamentals and Techniques of Biophysics and Molecular Biology. New Delhi: Pathfinder Publishing. p. 33. ISBN 978-93-80473-15-4. ^ Modern Spectroscopy (Paperback) by J. 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