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Original Article

Lasers and Coronavirus: Lasers and Raman Spectroscopy, Methods of Transportation, Symptoms, Diagnosis and Prevention

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Abstract: Corona Virus (COVID-19) belongs to the coronavirus, and is the largest of the RNA virus. The virus is a microorganism that cannot be seen with the naked eye but can be seen with a microscope. There are many types of viruses, and in recent years a new series of viruses has emerged called corona viruses, and today the seventh series of corona viruses, Covid_19. Which is still mysterious until now. This makes the scientists and researchers defiantly understand and study this virus for the purpose of finding a cure or vaccine for it. The urgent need to find quick, effective and low-cost methods for early detection of this virus. While it kills thousands of lives every day, we need to accelerate the conduct of virus detection analyzes and collect more information about it. Here, we can use the laser and use Raman spectroscopy, which is one of the methods of molecular spectroscopy, which uses the interaction of light with matter to obtain a vision of the composition of the material or its properties. As several studies, most of which are in the research and development stage, have demonstrated the possibility of using the laser and / or Raman spectroscopy for the purpose of detecting and diagnosing the virus accurately and within seconds.

Keywords: Lasers, Coronavirus, Raman Spectroscopy, Transportation, Symptoms, Diagnosis, Prevention

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1-1.Introduction:

A protein is a microscopic cell organism that is mainly made up of nuclear material due to the presence of a protein membrane inside it. It lives in a mixed environment, contributes to reproduction, and causes the emergence of viruses of varying severity. At the beginning of the century, viruses were known as a class of microbes characterized by being infectious, passing through pores, and needing living cells to be able to build, but the specification of their structure makes them mysterious. In the 1930s, mosaic viruses were obtained in their crystalline form, which suggested viruses consisting only of moths. However, it was soon discovered that there was nothing necessary for infection to be known, except that viruses were not seen by the eye until after the invention of the electron microscope in 1939 AD, and then the precise identification of their structure began, and a unique class of microbes became apparent in my theory.

Viruses are not new cells, they are excellent particles, as they consist of a protein covering that surrounds and protects them, or the physicist Sir Peter Medawar (1915-1987) called them “protein-coated bad news.” The structure is called the “viron,” while the external structure is called the “cap” or “viral capsid.” Viral capsids exist in various shapes and sizes, each of which has the categories of society to which its master belongs. They are constructed from subunits of production, “capsids,” and their composition is The substance in the center determines the shape of the virion. An example of this is the smallpox virus in the shape of a brick, while the herpes virus (herpes) has no polygonal molds on the body with the presence of a party, and the rabies virus has a shape on the body. What is the coronavirus, your difference? It is long and thin, resembling a stick. Some viruses have outer edges with their envelope called the “envelope”. Most deadly viruses are so small that they are unremarkable to see with an ordinary microscope. In general, we find them smaller than bacteria, ranging from approximately 100 to 500 times, and their diameters range from 200 to 300 times. However, this recently discovered giant mimivirus represents an exception to the rule, as it is about 700 nanometers in diameter and is larger than some species of bacteria. Inside the virus capsid or envelope is the available material, the genome, which is RNA or DNA, depending on the type of virus [1].

1-2 Coronaviruses

It is a large family of viruses that can infect humans with a range of illnesses ranging from the common cold to severe acute respiratory syndrome (SARS). These viruses can also spread to many types of animals. At the end of 2012, for the first time, a new coronavirus was detected in A valuable person in the Middle East, and this was not what had been seen before in humans.

The virus that is now known is called the Coronavirus that causes Middle East Respiratory Syndrome [2], which as of June 26, 2015 has been involved in more than 1,350 confirmed cases of human infection, and so far all patients and virus infections have had a direct or indirect connection to the Middle East. However, there has been unlikely human-to-human transmission of the infection from people who traveled daily to the Middle East. A large number of patients with coronavirus suffered primarily from systemic illness. However, efforts have been made to infect them also with a number of secondary complications, including Failure to do so, quality and failure of new organs, typical respiratory distress syndrome, and infection-free illness are preferred by many patients as a result of patients suffering from gastrointestinal symptoms, including diarrhea. To this day, about 30% of patients have died due to infection, and most of them are confirmed by one comorbid condition, including: However, many had been detected before in good health, and as of July 2, 2015, the median age of confirmed cases was widely reported to be 50 years (range less than 1 year to 99 years) and most patients were male [3]. Our current understanding of the Coronavirus that causes Middle East Respiratory Syndrome is a virus of animal origin that has been transmitted to humans in the Arabian Peninsula. It represents multiple cases as a result of their contact with dromedary camels or products related to them, directly or indirectly. Several studies have shown that the specific materials for the Corona virus that causes Middle East respiratory syndrome are widespread in herds of Arabian camels in the Middle East and Africa, and data derived from the epidemiological emergency indicate that the Corona virus has been circulating in camels for centuries, but the reason or reasons that led to the emergence of human cases for the first time Once in 2012 is unknown, and the specific types of exposure that are transmitted through the coronavirus transmitted from animals to humans have not yet been fully discovered. Human-to-human transmission of the virus is limited to a limited extent within the household. However, the framework of human cases reported to date to date has resulted from human-to-human transmission of the virus in health care settings, and has led to infection prevention and control in health care settings until they have been largely secondary to secondary cases in some cases. Sometimes, as was seen in the Kingdom of Saudi Arabia in the period from April to May 2014 AD and in the Republic of Korea in the period from May to July 2015 AD [4]. There are seven types of coronavirus:

HCOV-229E

HCOV-OC43

SAR-COV

HCOV-NL63

HKU1

Coronavirus that causes Middle East respiratory syndrome

nCOV-2019 currently known as COVID-19 [5]

In our research, we will discuss the latest type of coronavirus that is found in cities around the world, where scientists are working on how to eliminate it.

1-3. New CoronavirusCOVID-19

The Corona virus was discovered in China at the end of 2019 AD after the exceptional recording of cases in the city of Wuhan in central China.

The virus was named sars_cov_2

1-4 Symptoms, diagnosis and prevention

The most common symptoms are fever, cough, and difficulty breathing, and these symptoms can vary in severity. Other complications may also occur, such as pneumonia, and some patients may also develop problems in the digestive system or eyes (conjunctiva). If any sick symptoms appear, you must stay at home so as not to infect anyone. By sick symptoms, we mean:

- Fever (body temperature higher than 38 degrees Celsius, accompanied by a feeling of fatigue and sometimes muscle pain)

- Dry cough, which may be accompanied by a sore throat. If the symptoms are mild, you can take care of yourself. Do not leave the house until 24 hours after the symptoms disappear so as not to infect other people. I am committed to following the rules of hygiene and behavior, which are:

1- Wash hands well.

2- Sneezing or coughing into a tissue or elbow.

3- Keep your distance from others.

4- Avoid shaking hands.

1-5 Methods of transportation

The new Corona virus is transmitted mainly when there is close contact and for a long period of time when approaching an infected person at a distance of less than two meters and for more than 15 minutes. The disease is transmitted through droplets if the sick person sneezes or coughs, so viruses can infiltrate directly into the mucous membranes of the nose or mouth. The mouth or eyes of surrounding people via the hands. Contagious cough or sneeze droplets may be present on the hands and will therefore reach the mouth or nose if they are touched.

1-6 Infection and risks

The new Corona virus is a new virus that humans do not have immunity to, and therefore it may cause many infections and infections. Therefore, we must work to slow the spread of the new Corona virus as much as possible, and here we must work in particular to protect people who have a high risk of severe infection. These include those over the age of 65, as well as people with a previous illness such as high blood pressure, diabetes, heart and circulatory diseases, chronic respiratory diseases, cancer, and treatments that weaken the immune system.

1-7 How long does the virus remain on surfaces?

It is not known with certainty how long the virus causing Covid_19 will survive on surfaces, but it appears to be similar to other coronaviruses. Studies indicate that coronaviruses (including preliminary information about the virus that causes Covid_19) may remain alive on surfaces for a few hours or several days. This may vary depending on conditions (such as surface type, temperature or environmental humidity). [6]

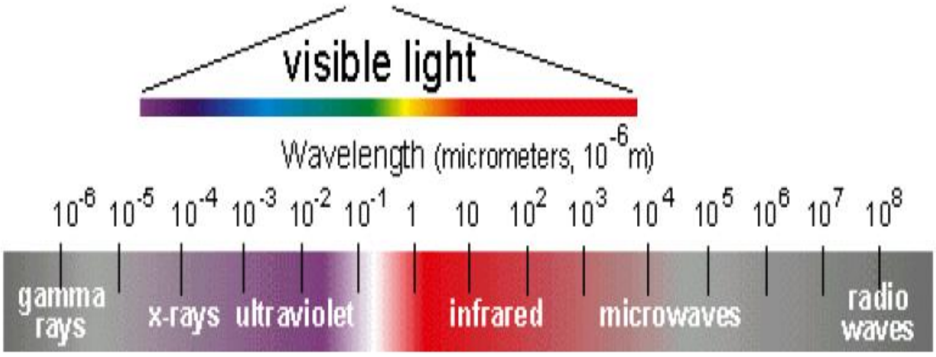
Lasers and Raman Spectroscopy

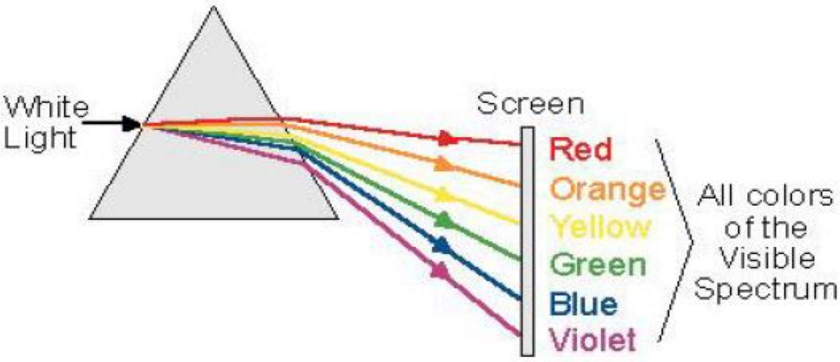
Laser 2-1 Laser

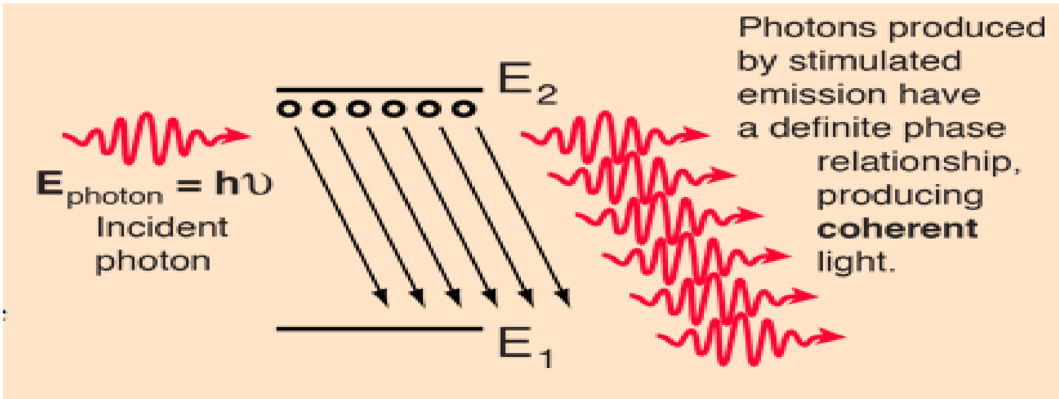
It means light amplification by stimulated emission of radiation. It is a light beam with photons that share a common frequency and whose waves are identical, so that the phenomenon of constructive interference occurs between its waves, transforming it into high energy. While an ordinary light source radiates irregular scattered light waves, it does not have the power of a laser. By using crystals of suitable materials (such as red ruby) of high purity, it is possible to stimulate their production of light rays of one color, that is, of one wavelength, as well as in one wave phase. When they match each other and are reflected several times between two mirrors inside the laser crystal, the waves are organized, overlap, and exit the device with great energy. Desirable, and to know the laser, you must actually know the electromagnetic spectrum, which starts from long radio waves to short waves to high-energy gamma rays. Electromagnetic rays consist, respectively, according to wavelength, of gamma rays, X-rays, ultraviolet rays, visible light, infrared rays. Microwaves, then radio waves. Maxwell explained the nature of these rays on the basis of the theory of electromagnetic dynamics, so he called them electromagnetic rays. These rays, according to Maxwell's theory, are an electric field and a magnetic field, each perpendicular to the other and to the direction of the rays' propagation. The rays propagate in the form of a sine wave and are symbolized For the electric and magnetic field vectors E and B, respectively.

The speed of propagation of rays in a vacuum is constant and is known as the speed of light, symbolized by the symbol C and equal to m/s 108*3. As is known, the narrow region of the spectrum known to us as visible or white light consists of the following light colors: red, orange, yellow, green, blue, and violet. The frequencies and wavelengths of these radiations are different and disturbed, so they are more like noise compared to sound waves, while we find The laser light is organized and focused. In lasers, disturbances in the waves cause them to interconnect. Photons (the basic units of all spectral radiation) are emitted in the form of regular bursts of one frequency. Because the waves interconnect, the photons strengthen each other and increase their ability to transfer energy.

Laser technology has expanded to include beyond the ultraviolet wave region towards high-energy X-rays, and each wavelength in these regions gives the ability and assistance to humans in creating various applications.







2-2 Characteristics of the laser beam

• Monochromatic: It means that it has a narrow spectral width that results in a single, pure frequency, and this wave characteristic was unique to radio rays.

• Collimation of the light beams: This means that the scattering or dispersion in the beam is non-existent, and it is also naturally focused without the need to use lenses, and its diameter may reach less than the diameter of a pin, and it can be transmitted over long distances with little loss of energy, especially if there are no materials. Absorbed in its course.

• Directionality: Ordinary light is found to be obtuse, and the obtuseness of that light increases as it moves away from the source of that light, as all traditional sources are light that is emitted in all directions (such as the light emitted from a light bulb). "Directionality" is a characteristic of laser light that causes it to move. In one direction within a narrow cone of divergence.

All types of light eventually scatter (diverge) as they move through space, but laser light is much more directional than conventional light from any source, and therefore less divergent.

• Coherence: The correlation between the waves of a single beam is very high and simultaneous, and this helps the light waves or photons to strengthen each other to give high energy and power to the single beam. This correlation is either a constructive correlation in which the phase difference (phase) between the waves is equal to zero, or a destructive correlation in which There is a phase difference between the waves and the correlation is what distinguishes laser light, and this correlation appears when stimulated emission occurs, which is an essential factor in the amplification of light, so that the emitted photons have a specific phase difference and are compatible with each other.

• Light intensity: The intensity of the beam is high and it is focused in a beam with a narrow diameter that does not exceed one millimeter. When using appropriate optics, it can be exposed according to need. In addition, we can focus it in a small spot that has a huge power density (which is the power per unit area).

2-3 Advantages of the laser beam

1- The light beam of a laser beam does not have mass. Because the mass of photons that make up this laser beam is zero.

2- The light beam can be a continuous wave or a pulse, and these pulses take multiple forms and different rates and repetition rates, starting from a pulse per second or its parts to millions of pulses per second.

3- Ease of control of the laser beam, especially those with light frequencies visible to the naked eye.

4- The ease of managing and maintaining the laser when compared to other atomic and nuclear radiation.

2-4 Disadvantages of using laser

1- A dangerous package, especially when exposed to the sense of sight.

2- It requires a high capacity for operation, as research methods can take various forms and in their entirety convert different energies into light energies.

3- It requires extreme accuracy in matching the optical levels to start the laser emission.

2-5 basic elements of a laser

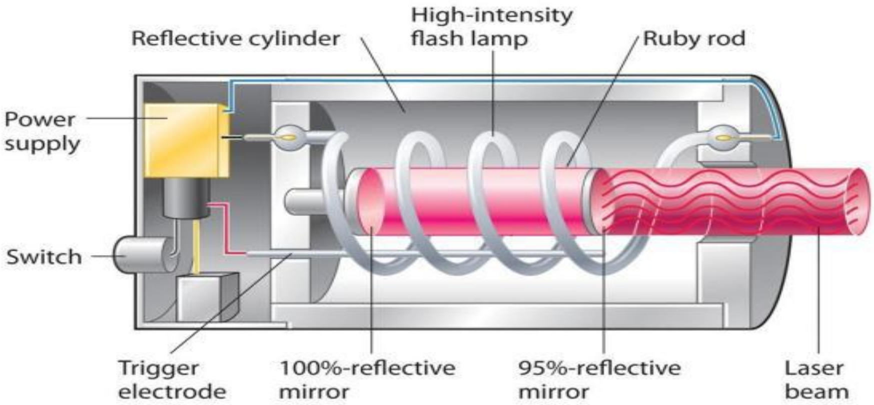
The laser element carries within it the ability to penetrate the depths of materials, whether gaseous, solid, or liquid, to heat their atoms and molecules and stimulate or encourage each of them to produce and emit radiation that is unique in its physical characteristics, unique in its application features, superior in quality in its properties, consisting of light particles called B: Photons, with frequencies or wavelengths that depend on the type of substance stimulated (excited) and the method used in induction (excitation). This beam may be visible to humans or invisible, continuous flow or intermittent (pulsating).

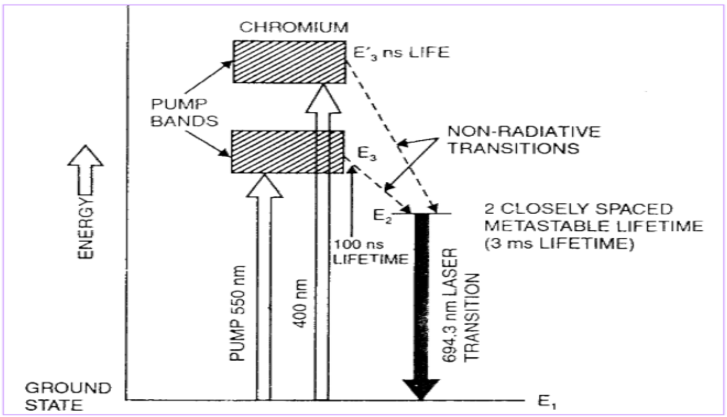
It is known in materials science that various substances consist of atoms of one or more elements from the periodic table, the number of which does not exceed 104. The atoms of these elements combine in a variety of ways to form an innumerable number of molecules, which in turn form the various compounds, giving the known properties of the substances. It is theoretically possible to emit a laser beam from all of these elements or their compounds, and in practice this process requires finding appropriate induction methods. During the past few years, it has actually been achieved to form a laser beam from a number of atoms and molecules, whether in the form of gaseous, solid or liquid compounds. Some of these devices are sold commercially and some are under trial and research. These devices are distinguished by their different shapes, sizes, and powers, but the basics of their design are the same, which is the availability of three main common elements (the physical medium, the power source, and the resonator).

2-5-1: Material Medium

The active material currently commonly used to produce laser radiation is as follows:

Crystalline solid crystals: such as synthetic rubies, aluminum garnets, and glass called ND:YAG. For example, the active medium of the ruby laser device is an aluminum oxide crystal inlaid with chromium atoms, which are responsible for the properties of the active medium in the ruby laser device to produce the red color of laser rays, so that the chromium atoms absorb blue and green light and reflect the red color. The active medium here has a cylindrical shape. At one end of this cylinder there is a mirror that completely reflects the rays, and the other end has a mirror that partially reflects the rays. This cylinder is surrounded by a high-intensity optical core that works to pass white light into the active medium. It is known that the spectrum of electromagnetic white light consists of colors. Therefore, the role of the chromium atoms is to absorb the blue and green color of this light, which leads to the chromium atoms gaining high energy, enabling it to move from the ground energy level to a higher energy level. As these electrons return to the ground energy level, we emit red light. When this red light is emitted, the mirrors Reflecting light (partial and total) by reflecting this light again and returning it to the active medium, which results in excitation.





Energy levels of chromium ions is Ruby laser

Gaseous substances (GAS):

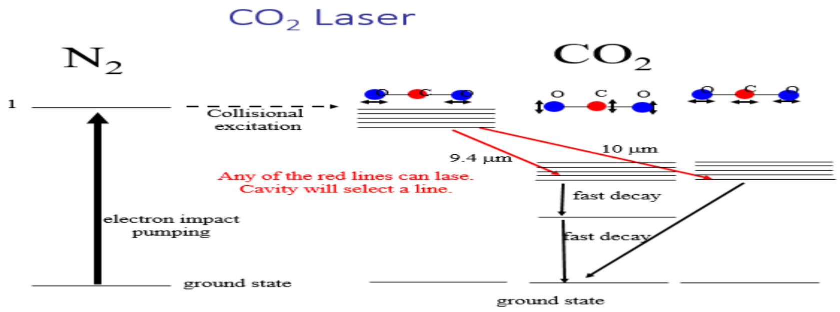
such as a mixture of helium and neon, He-Ne, a mixture of helium and cadmium, He-Cd, and water vapor, H2O. If we take the active medium, helium-neon, which is considered one of the most famous active media materials for gaseous lasers and is not financially expensive, this type of laser works at a wavelength of 632 nanometers in the red color region of the electromagnetic spectrum, as well as at a wavelength of 543.5 nanometers in the green color region of the electromagnetic spectrum. The infrared region has a wavelength of 1523 nm. The proximity of the energy level (20.60 MeV) of helium atoms to the energy level (20.66 MeV) of neon atoms may cause collisions of atoms in the two levels, and a transfer of energy occurs to the neon atoms, and thus these atoms move to higher levels, resulting in the continuous emission of photons in random directions and phases. Different, but there is one wavelength required, and it is important here to know the device’s composition and how it works. The helium-neon laser device is the active medium (a mixture of helium and neon gas) inside a glass tube under low pressure, and the power source is an electrical discharge of the order of 1000 volts. The discharge process takes place through the cathode and anode located at both ends of the tube. The process of producing the first laser begins when a collision occurs between the discharge electrons and the helium in the gas. This process causes the helium atoms to be excited and move from the ground level to the 21S0 and 23S0 levels, which are the excited levels. A collision occurs between Helium atoms are excited in the ground plane with the neon atoms close to it at this energy level, so that an energy transfer occurs to the neon atoms close to it at this energy level, so that an energy transfer occurs to the neon atoms, and therefore the electrons of the neon atoms will move to the 3S2 level as a result of compatible energy levels. Helium atoms with the energy levels of neon atoms, and this gives the following differential equation:

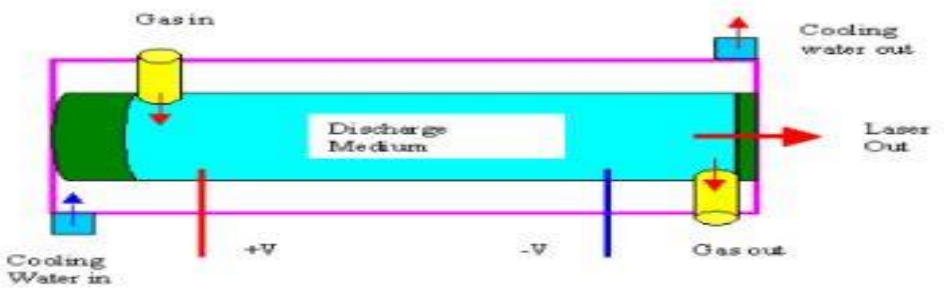
He(21S)*+Ne +ΔE He(11S) +Ne3s2*

Gaseous molecules:

such as carbon monoxide (CO) and carbon dioxide (CO2). This type of active medium has the ability to produce a continuous laser with a power of 10 kilowatts, and its method of operation is similar to the way a helium-neon laser works. It uses an electrical discharge process to pump electrons using a percentage of gas. Nitrogen as a gas. The carbon oxide laser has an effective role and the laser can be produced even if the efficiency is around 30%. It is used in welding and cutting operations. The emission of this type of laser occurs at a wavelength of 10.6 micrometers and its radiation power ranges from 10 watts to 25 kilowatts or 100 kilowatts. The active medium is a mixture of carbon dioxide, helium, and nitrogen gases in ratios of Co2:N2:He:0.8:1:7.

The process of pumping electrons takes place either through an electrical discharge with an alternating current or a direct current, and the process takes place when the energy of the electrical discharge is absorbed in the nitrogen gas only. Part of this energy is absorbed directly by the carbon dioxide gas molecules and then rises from the ground energy level (000) to the energy level. The highest is (001). Also, a large number of carbon dioxide molecules collide with nitrogen molecules and thus the carbon dioxide molecules are excited, and then the carbon dioxide molecules in the E1 level begin to lose their energy and fall to the energy levels (100) or (020) shown in Figure (2-10) causes the emission of laser light at a frequency of 10.6 micrometers or 9.6 micrometers, respectively. The remaining two decays are from levels (100) to (101), (020) to (010), or from (010) to the ground plane (000). They all lose their energy in the form of heat instead of light. Model of a carbon dioxide device.





Liquid dye: These are various organic chemical dyes dissolved in water. This type of laser works at continuous frequencies with specific molecules of chemical dyes, as the molecules of these dyes have a large number of spectral lines, and each spectrum line has its own characteristics, and the frequency of these overlapping lines can be adjusted to produce an effective laser. Rhodamine 6G is considered one of the most famous types of dyes used. In fact, its active medium is a dye in an aqueous medium.

Semiconductor solid materials: such as gallium arsenic (Ga-As). The active medium of this type of laser gives monochromatic, coherent light through a p-n junction consisting of layers of gallium. At two ends of this compound, parallel mirrors are placed, one of which completely reflects the light, and at the other end, mirrors that partially reflect the light. The length of the junction is related to the wavelength of the outgoing light. This type of junction is Forward bias type.

2-5-2: Source of Energy

It determines the induction method to excite the active material and encourage it to emit laser radiation. The energy sources currently used are varied, including:

Electrical energy: It consists of using direct electrical energy in two ways, such as:

Using radio frequency sources as input energy or using electrical discharge in direct current, for example, carbon dioxide gas laser, helium neon laser, argon gas laser... etc.

Radiant energy: known as light pumping, can be emitted from two main sources:

Using large power incandescent lamps, such as the ruby laser.

Or using a laser beam as an energy source for another laser. The latter is commonly used to produce many laser radiations in different regions of the spectrum. An example of this is commercially available liquid dye lasers.

Thermal energy: Both kinetic pressure of gases and changes in temperature can excite materials to emit laser beams.

Chemical energy: Chemical reactions between a mixture of hydrogen and fluorine give energy, causing these molecules to emit laser radiation, as well as with a mixture of deuterium fluoride and carbon dioxide. An example of this is chemical lasers.

2-5-3: Resonator

It is the vessel that contains and activates the enlargement process, and is usually used either:

***External resonator:** It is two parallel mirrors at the end of the tube containing the active substance, and the multiple reflections between them are the basis for the process of optical amplification, as in gas lasers.

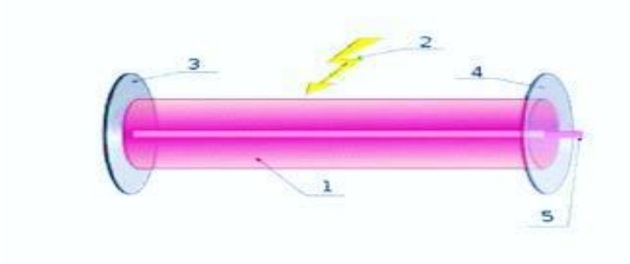
***Internal resonator:** It consists of coating the ends of the active material to work on the mirror, as in the ruby crystal laser, the aluminum and glass garnet laser, and in solid lasers in general.

In both cases, one of the mirrors must be completely reflective of optical photons, and the other must allow partial penetration so that the laser beam can exit from it outside the resonator.

Let's take an example of this: the Ruby laser

In designing the first laser, a rod made of artificial ruby crystals (dotted with chromium atoms) was used as the active material, two inches long and half an inch in diameter. The two ends of this rod were plated with silver to form a light-reflecting chamber inside it, thus forming a resonator made of the same material. One end was coated to be less reflective of light than the other, in order to allow some of the internal reflected rays to pass outside the sapphire rod. This sapphire rod was surrounded by a spiral tube containing xenon gas, The induction here is done by a light source of energy. When the ruby absorbs this flash of light energy, the chromium atoms begin to excite, as the chromium atoms gaining this energy raises them to higher energy levels than they were, and the chromium atoms are unable to withstand these higher energy levels. More than one millionth of a second, it then begins to descend (or what is known as dissolution), transferring the acquired energy to the neighboring ruby atoms, which in turn emit it in the form of light minutes or photons, which are reflected right and left inside the ruby rod at the speed of light, collecting in a moment of time a huge number. Of light particles interconnected in phase from all the ruby atoms, and when the energy of the photons reaches a sufficient level to penetrate outside the rod in the form of an intense interconnected light beam, it is then called laser emission, while the device is called a ruby laser. Figure (2-13) shows a model of the laser device.

The following figure shows the role of the main parts of the laser device.



1. Active laser medium

2. Laser pumping energy to stimulate the medium

3. High quality beam reflector

4. Laser beam output regulator (planar or concave lens) Output coupler

5. Laser beam

2-5-4: Lens specifications

The inner surface of the lens may be flat or concave, depending on the desired purpose. The inner surface of the lens is coated with semi-reflective silver paint so that the laser beam can exit from the center to the outside. If there is a desire to collect the emerging beam and focus it into a focus, the outer surface of the lens will be concave. The outer surface is also coated with a paint that prevents reflection in order to allow the resulting laser beam to exit without loss.

Lens reflection coefficient:

The number of reflections of light rays accumulated within the medium depends on the type of medium used. In the helium-neon laser, we need a mirror reflection of 99% for the device to work. In the case of the nitrogen laser, there is no need for internal reflection (0% degree of reflection), as the nitrogen laser has a superior degree of radiation production. On the other hand, the properties of the lens related to the reflection of light depend on the wavelength of the light, which is why the optical properties of the lens are given special attention when designing the laser device. .

2-6 Conditions for laser emission

To obtain laser rays, it is necessary to meet three basic conditions:

1. Provides inductive emission

2. The occurrence of reverse enumeration

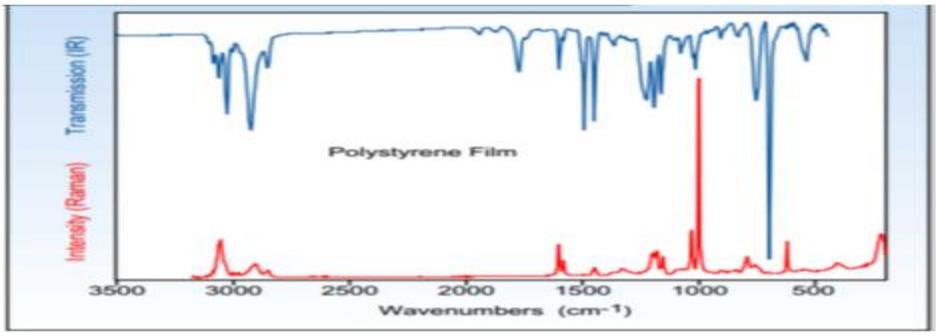
3. Finding optical magnification.[7]

2-7 Raman spectroscopy

The principle of Raman spectroscopy: In the year 1928, the Indian scientist (Chandrosek venkat hara Raman) presented his work on the mutual interactions between matter and light, which was known as the Raman effect or Raman spectroscopy. Raman actions are defined as mutual effects that occur mainly between the electric field of usually single-wave radiation (laser) and the substance, resulting in changes in the polarization of its molecules that result in the appearance of propagation spectra. We call them “diffusion or scattering Raman spectra.” The Raman spectrum analysis technique is known as one of the most advanced techniques. To define the material quickly and effectively.

2-8 Raman spectroscopy

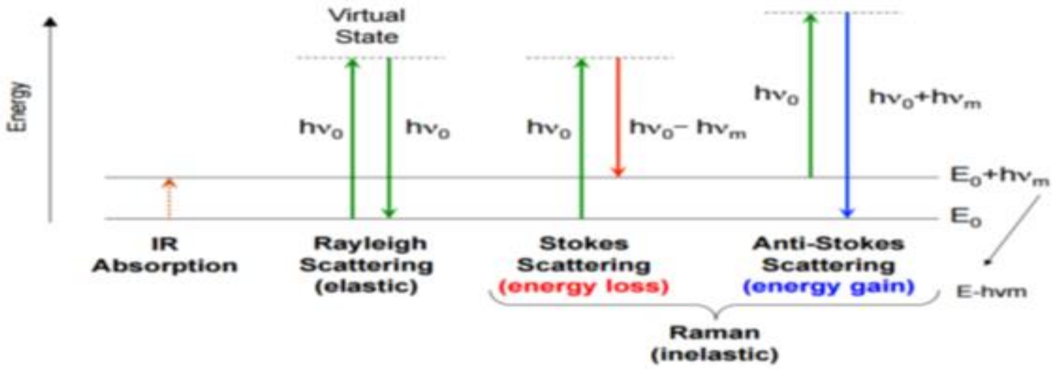
Raman spectroscopy is a method of molecular spectroscopy, which uses the interaction of light with a substance to gain insight into a substance's composition or properties such as the Fourier transform infrared. The information available through the results of Raman spectroscopy results from the process of light scattering, while the infrared conversion spectroscopy technique relies on the absorption of light. Raman spectroscopy produces information about the vibrations that occur within molecules and from one molecule to another and can provide additional understanding about the interaction. Raman spectroscopy and Fourier transform infrared spectroscopy both provide a spectral characteristic of specific vibrations of a molecule (“molecular fingerprint”) and both techniques are valuable for material identification. However, Raman spectroscopy can provide additional information about lower frequency modes and vibrations that provide insight into the crystal lattice and molecular structure. Raman spectroscopy is used in the production line to monitor crystallization processes and reveal reaction mechanisms and kinetic features. This data combined with analysis tools allows for informed understanding and improvement of the interaction. Raman spectroscopy is considered a complement to infrared spectroscopy, as shown in the example below



2-9 Principle of Raman spectroscopy

When light interacts with molecules in a gas, liquid, or solid, the vast majority of photons are scattered or scattered with the same energy as the incident photons. This phenomenon is known as elastic scattering or Rayleigh scattering. A small number of these photons, about 1 photon out of every 10 million photons, will be scattered at a different frequency from the incident photon. This process is called inelastic scattering, or the Raman effect after the scientist C.V. Raman, who discovered it and won the 1930 Nobel Prize in Physics for his work. Since then, the Raman effect has been used in a wide range of applications from medical diagnostics to materials science and reaction analysis. Raman allows the user to collect the vibrational signature of a molecule, giving a look at how it assembles, as well as how it interacts with other molecules surrounding it. The Raman effect can be described in a simple way as the inelastic scattering of light incident on a substance. When a photon of visible light with an energy so small that it cannot initiate an electronic transfer with the molecule interacts, it is scattered in one of the following ways:

It can be elastically dispersed and retain its energies that fall on the molecule, and this is Rayleigh Scattering, or it can suffer from inelastic scattering, in which case it either gives the molecule part of its energy or gains part of the molecule's energy. The photon that suffers a loss in energy gives Stokes Scattering, while the photon that gains energy from the molecule gives Ant Stokes Scattering. The energy that the molecule gains appears in Stokes scattering as oscillatory energy, and when the molecule has energy in excess of the energy of the ground state (at an oscillatory state Excited), it is this energy that loses photons to anti-Stokes scattering.



The Raman effect comprises a very small fraction, about 1 in 10^7 of the incident photons.

Basic Properties of Raman spectra

First: The radiation coming into the sample is single-wave, that is, coming from a laser beam where the intensity of focus allows

The beam and single-wavelength radiation cause the phenomenon of dispersion.

Second: In Raman spectroscopy, the molecules under study are not required to be polarized, since even in...

The case of analog molecules that do not have an electric dipole allows incoming light radiation

By affecting molecules and changing their electronic distribution

Third: Rotation and vibration in Raman spectroscopy Using the dipole formed, the radiation converts part of its energy to cause changes in the state of rotation or vibration.

Origin of Molecular Spectra

All spectra arise from the transition between energy levels in the formation of the molecular spectrum as a result of changing the internal energy of the molecule when it absorbs or emits electromagnetic rays in specific and separate quantities (photons) with each energy E. The change in energy is expressed by the following relationship:

(1) $\Delta E = E2 - E1 = hf = hc /$

Where c is the speed of electromagnetic rays in the same medium in which the wavelength is measured.

cλ is related to the frequency of electromagnetic rays by the relationship fλc=, and the values of cλ depend on the nature of the medium in which it is measured, whether it is empty or air.

The difference in energy between two partial energy levels divided by Planck's constant is numerically equal to the frequency of the rays, and this relationship is expressed by Bohr's law:

E = E2 – E1= hf (2)Δ

If the molecule is at the energy level E1, it can be excited to a higher energy level E2 if it absorbs electromagnetic rays with a frequency equal to ΔE=hf.

The spectrum resulting from this transition is called the absorption spectrum. However, if the molecule moves from energy level E2 to energy level E1, it emits single-wavelength rays with a frequency of ΔE/h, and the spectrum in this case is called the emission spectrum.

Electrons rotate in orbits around the nucleus, just as the nuclei of atoms in the molecule rotate around the center of mass, and these nuclei also vibrate along the axis connecting their centers. Each of these movements is accompanied by energy, so the total energy of the molecule, symbolized by the symbol Em, is:

Em= Ee + Ev + Er (3)

Where Er is the rotational energy

Ev vibrational or oscillatory energy

EeElectronic Energy.

This is in addition to the translational kinetic energy of the molecule in vacuum, the amount of which is very small compared to these energies, so its value is neglected, noting that:

Ee ≈ Ev103 ≈ Er 106 (4)

When a molecule is exposed to electromagnetic radiation and its energy is transferred to it, that is, when the molecule absorbs radiation energy, its previous energies change according to the relationship:

E = hf (5)

Since the rotational energy levels are relatively close to each other, the transition between these levels occurs at low frequencies (from 102 cm-1 to 10 cm-1). This range falls in the microwave region and the far-infrared region. The distance between the vibrational energy levels is wider than in the case of the oscillatory energy levels. Rotational energy, therefore, the transition between higher energy levels requires higher frequencies from (104cm-1 to 102cm-1), which is the infrared region. The distances between the electronic energy levels are larger than the distances between the vibrational energy levels, and this requires greater energy to move in the range (from 1104 cm to 105 cm-1) where the visible and ultraviolet spectrums are, that is, the rotational, oscillatory, and electronic spectra appear, respectively, in the microwave and infrared wave regions. Far-infrared, visible and ultraviolet light.

It is noted that if a molecule absorbs ultraviolet or visible rays, this changes its electronic, oscillatory, and rotational energy. However, if it absorbs infrared rays, this changes its oscillatory and rotational energies. In the case of absorption of far-infrared rays or microwave waves, only its rotational energy changes.

Spectra of Diatomic Molecules

Each of the atoms of diatomic molecules moves near or far from the other in a simple harmonic movement, and the displacement of one position from the equilibrium position is a sinusoidal function of time. The movement of the two atoms can be reduced to the harmonic movement of a single particle around an equilibrium position, and this is the model of the harmonic movement of the simple pendulum. [8].

Virus detection

Detection using a PCR device

The "PCR" test, which is known as the "polymerase chain reaction" test, is one of the most common tests conducted by hospitals to determine the strain of the virus present in the human body. It can also determine the extent of its spread and track the extent of the patient's recovery from it. This test is used to detect several viruses, whether they are related to Influenza or even AIDS, enteric viruses, and viruses related to the respiratory system, including (Covid-19) or the new Corona virus, according to the World Health Organization. The test allows the detection of the virus's DNA through "polymerase chain reaction" so that the genome carried by the virus is determined. Some also conduct this test in order to know the human DNA, which is used to prove lineage, and it also includes DNA cloning. The examination must be conducted in accredited medical laboratories and by specialists, where samples are taken from the upper respiratory tract, pharynx and nose, in addition to an attempt to reach the lower respiratory tract.

3-1-1 Samples that must be taken from the patient

The sample extraction stick must reach a medium depth between the tip of the nose and the earlobe for the most accurate results. After extracting the samples, they are sent to the laboratory for processing, the results of which take between two to three hours to appear, and can extend to six hours sometimes. This examination is one of the expensive examinations because the devices used in it are expensive.

The World Health Organization relied on this examination during the spread of the Corona virus that causes Middle East respiratory syndrome. Since the beginning of the crisis last December, China has also relied on this examination to detect those infected with the new Corona virus, as it relied on extracting samples from the nose and throat of infected or suspected patients.

Who is subject to testing?

In countries where there are cases of Coronavirus, this diagnostic test is only performed on patients who are classified as “suspected infections.” To be included in this category, a person must meet several specifications, including symptoms and travel history. Although it is widely relied upon in China and several countries around the world, some results may be falsely negative for various reasons, including the efficiency of technicians, equipment, and how samples are collected. The examination must be conducted in accredited medical laboratories and by specialists, where samples are taken from the upper respiratory tract, pharynx and nose, in addition to an attempt to reach the lower respiratory tract.

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Portable virus detection devices in minutes

Viruses infect all organisms and cause many serious diseases. Viruses continue to evolve in a very rapid and unexpected manner, which puts us in front of a great challenge to detect and diagnose them. Viruses are usually identified by isolating them from samples (whether environmental or medical) using some techniques. Molecular biology, which may take several days.

According to a study published in the journal PNAS, researchers from the University of New York and the University of Pennsylvania were able to develop a small hand-held device they called the Viron to detect viruses at a low cost within a few minutes, by using an atomic spectrometer technique with nanoparticles to capture viruses directly from medical samples.

Viruses are the most abundant organisms on Earth and are responsible for many known epidemics, such as bird flu, Ebola, and Zika. The Global Virome Project (The Gold Virom Project) also reports that the number of unknown viruses that infect animals and birds and that can be transmitted to humans is estimated at 1.67. One million viruses, and according to the World Health Organization, early detection of viruses helps to quickly take countermeasures to limit their spread.

Also, the usual methods for detecting viruses are impractical in critical cases or that require rapid diagnosis, which prompted scientists to search for quicker and more effective methods over the course of three years. It was found that vibrational Raman spectroscopy is an ideal method as it is used to determine the chemical composition of materials by shining A laser beam is applied to it and the resulting vibrational optical spectrum is analyzed.

The Viron device is composed of carbon nanotubes of varying size, arranged vertically to resemble forests, and decorated with gold nanoparticles. This composition helps capture viruses from samples and increase their concentration before exposing them to laser rays.

The use of gold nanoparticles led to improved Raman spectra through a technique known as SER, or surface-enhanced Raman spectroscopy, which led to obtaining a distinctive spectrum that we can attribute to a virus.

The laser interacts with viruses and gold particles, which leads to the excitation of the atoms on the surface of the virus proteins, and each atom will interact with the atoms surrounding it, producing distinct frequencies and vibrations for various viruses, like a fingerprint that can be measured and analysed. The Viron device includes an algorithm that teaches the machine how to collect these results to create a database that can later be used to identify unknown viruses in a few millimeters of different samples.

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