ORIGINAL ARTICLE

INTERNATIONAL JOURNAL OF ARTIFICIAL INTELLIGENCE

ISSN: 2692-5206, Impact Factor: 12,23
American Academic publishers, volume 05, issue 10,2025

Journal: https://www.academicpublishers.org/journals/index.php/ijai

THE MEASUREMENT OF THE SUBSTANCE IS ANALYZED USING THE AUGER SPECTROSCOPY METHOD

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Annotacia: This article presents the current conceptual methods for analyzing the composition of substances, along with their analysis methods Izertlev's research investigated the accuracy and convenience of research using the Ozhe spectroscopy method for scientific and laboratory activities. Actually atomic spectroscopy is widely used for green chemistry.

Key words: atom, spectroscopy, valence, electron, effect, interference, radio waves.

Copies of atomic spectra are related to the transitions of outer-valence electrons and electrons moving from one energy state to another.
When electrons move from one energy level to another and return to their original level, the atom emits light.
Depending on the wavelength and frequency of the emitted light, the atomic spectrum is divided into optical and X-ray spectral types.
The atomic emission spectral lines were first obtained in 1860 by Kirchhoff and Bunsen.

The atomic emission analysis method is aimed at studying the emission spectra of atoms moving with energy in a flame or in an electric discharge.
In addition, when the electron energy decreases, secondary X-rays also appear, which are specific to a given spectrum.

The maximum frequency (νmax) of continuous X-ray radiation depends on the voltage (U) in the X-ray tube and is related by the equation **U = hνmax**.
Thus, the emission X-ray spectrum consists of characteristic X-ray lines superimposed on a continuous background.

Characteristic X-rays are produced not only when atoms are bombarded by electrons, but also when they are irradiated with high-energy electromagnetic radiation.
In this case, a continuous X-ray spectrum does not appear.
Such X-rays are called **fluorescent radiation**.

However, it should be noted that when electrons move from lower to even lower energy levels, they do not always produce X-rays directly.
In such cases, the electron shells are restructured, and one of the electrons is ejected from the atom.
As mentioned earlier, this process is called **electron emission**, or the separation of an electron from an atom.

The interaction of electromagnetic radiation with matter changes the properties of the material, causing it to emit, absorb, or scatter radiation.
This process can be understood as the generation of signals — that is, the interaction reveals the characteristics of the studied material.
The frequency of the signal reflects the unique properties of the substance, while its intensity represents the concentration or quantity of those properties.

In chemical analysis, electromagnetic radiation is used within a wide spectrum range (10^6–10^{20} Hz) and wavelengths (10^2–10^{-12} m).
This includes **radio waves** (10^6–10^8 Hz, 10^2–1 m), **visible light**, **ultraviolet rays**, **infrared rays**, and **X-rays** (3×10^{17}–10^{20} Hz, 2×10^{-9}–10^{-12} m), among others.

In 1888, **G. Maxwell** developed the theory of radiation, which later led to the discovery of electromagnetic waves by **Heinrich Hertz**.
Electromagnetic radiation in the radio wave range is emitted by macroscopic objects (antennas, transmitters) and can be received by corresponding detectors.

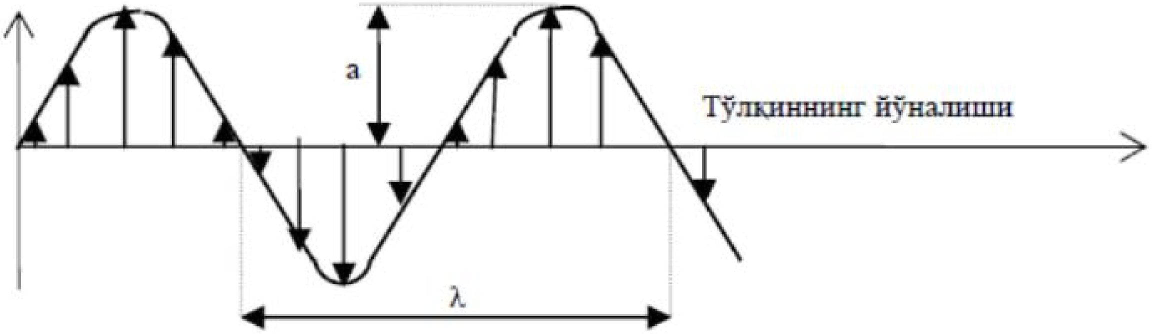
Optical (infrared, visible, and ultraviolet) and X-ray spectra arise from changes in the energetic state of matter.
These types of radiation waves differ and consist of sets of waves that are not in the same phase.
Interference can be observed in radio waves, while in optical radiation, interference can be detected only after splitting the light beam into several parts.

The invention of the **laser** (by Basov and Prokhorov in 1954, Schawlow and Townes in 1958, and Maiman in 1960) demonstrated the coherence and unity of electromagnetic radiation.

Electromagnetic radiation can be described as both a wave and a stream of discrete particles known as **photons**.
The wave model describes properties such as speed, frequency, wavelength, and amplitude.
No medium is required for the propagation of electromagnetic waves — they can travel through a vacuum.
However, absorption and emission of radiant energy cannot be explained by the wave model alone; they also exhibit particle-like (photon) behavior.

The energy of photons depends on the speed of light and their frequency.
Depending on the wave propagation form, electromagnetic radiation can be represented by **electric and magnetic field vectors** (see Figure 1).
The electric field intensity vector is proportional to the magnitude of the electric field at a given time.

As seen in Figure 1, the change in electric field intensity over time follows a **sinusoidal variation**.



The strength of an electric field is determined by the properties of matter such as absorption, reflection, refraction, and transmission.
The time required for each successive maximum of a wave to pass through a fixed point in space is called the **period of radiation (T)**.
The number of oscillations per second of the field is called the **frequency (ν)**, and it is defined as **$\nu = 1/T$ (Hz)**.

It should be noted that the frequency depends on the source but does **not** depend on the medium through which the light propagates.
However, the **propagation velocity of the wave (υ_i)** depends on both the medium and the frequency (the index i indicates the frequency dependence of the velocity).
The distance between two successive maxima or minima of a wave is called the **wavelength (λ)**.

To describe electromagnetic radiation, the concept of **wavenumber ($\bar{\nu}$)** is also used:
$\bar{\nu} = 1/\lambda$,
which is measured in cm^{-1} and indicates the number of waves per centimeter.

Any radiation is characterized by **power** and **intensity**.
The **power (W)** of radiation is equal to the amount of energy incident per second on a given surface.
The **intensity (I)** of radiation is the power per unit area of the surface of a body.

Discrete Properties of Radiation

Radiation can also be considered as a stream of discrete particles, each possessing a definite amount of energy—called **photons** or **quanta**.
The energy of a photon depends on the frequency of radiation according to the formula:

$E = h\nu$,

where h is **Planck's constant (6.63×10^{-34} J·s)**.

The energy can also be expressed in terms of wavelength or wavenumber as:

$$\mathbf{E = hc/\lambda = h\,c\,\bar{v}}.$$

From this equation, it follows that wavenumber (or frequency) is directly proportional to energy.

The spectrum of electromagnetic radiation covers a very wide range of wavelengths and regions. For example, the energy of an X-ray photon ($\lambda \approx 10^{-10}$ m) is about **ten thousand times greater** than the energy of radiation emitted by a heated tungsten filament ($\lambda \approx 10^{-6}$ m).

Molecular Spectra

Unlike atomic spectra, molecular spectra are more complex because they consist of **electronic, vibrational, and rotational** energy components.
Therefore, the total energy of a molecule in an excited state is equal to the sum of these three energies:

$$\mathbf{\Delta E = E_e + E_v + E_r},$$

where $\mathbf{E_e}$, $\mathbf{E_v}$, and $\mathbf{E_r}$ correspond to electronic, vibrational, and rotational energies, respectively.

Since these energies are related by the ratio $\mathbf{E_e > E_v > E_r}$,
each electronic energy level corresponds to several vibrational levels, and each vibrational level corresponds to several rotational levels.

Therefore, while atoms absorb or emit photons of definite frequencies, producing **distinct spectral lines**,
molecules exhibit **bands** in their spectra due to the combined transitions.
A **spectral band** consists of many closely spaced spectral lines.

Because each molecule or its structural component (functional group) has unique spectral bands, one can distinguish between different molecules or functional groups based on these spectral characteristics — a principle used in **qualitative analysis**.

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