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RESONANCE STRUCTURE OF THE SCATTERING CROSS SECTIONS IN THE MIE PROBLEM AND THE AMPLITUDES IN THE COMPLEX PLANE

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The talk is devoted to the study of the scattering and extinction cross sections behavior in the case of electromagnetic plane monochromatic wave scattering by a biisotropic sphere of radius R imbedded in another biisotropic medium. Electromagnetic properties of biisortopic media are described by the constitutive relations $\vec{D}=\varepsilon\vec{E}+(\chi+i\alpha)\vec{H}$; $\vec{B}=(\chi-i\alpha)\vec{E}+\mu\vec{H}$. For solving the boundary problem we use the theory of spherical vectors $\vec{Y}^{L}_{JM}(\vec{n}_r)$ and the spherical waves $\vec{F}^{(z)}_{J\nu M}(k\,|\,\vec{r})$ [1-3]:

$$\vec{E}^{in}_{\nu}(\vec{r})=\sum_{J=1}^{\infty}E_J\vec{F}^{(j)}_{J\nu\nu}(k_\nu\,|\,\vec{r});\quad \vec{H}^{in}_{\nu}(\vec{r})=-\sum_{J=1}^{\infty}E_Jb_\nu\vec{F}^{(j)}_{J\nu\nu}(k_\nu\,|\,\vec{r});\tag{1}$$

This allows to represent the solution in the form

$$\vec{E}^{sct}_{\nu}(\vec{r})=-\sum_{J=1}^{\infty}E_J\sum_{\sigma=\pm1}f^J_{\sigma\nu}\vec{F}^{(h^1)}_{J\sigma\nu}(k_\sigma\,|\,\vec{r});\quad \vec{E}^{prt}_{\nu}(\vec{r})=\sum_{J=1}^{\infty}E_J\sum_{\sigma=\pm1}g^J_{\sigma\nu}\vec{F}^{(z)}_{J\sigma\nu}(k^1_\sigma\,|\,\vec{r});$$

$$\vec{H}^{sct}_{\nu}(\vec{r})=\sum_{J=1}^{\infty}E_J\sum_{\sigma=\pm1}f^J_{\sigma\nu}b_\sigma\vec{F}^{(h^1)}_{J\sigma\nu}(k_\sigma\,|\,\vec{r});\quad \vec{H}^{prt}_{\nu}(\vec{r})=-\sum_{J=1}^{\infty}E_J\sum_{\sigma=\pm1}g^J_{\sigma\nu}b^1_\sigma\vec{F}^{(z)}_{J\sigma\nu}(k^1_\sigma\,|\,\vec{r});\tag{2}$$

$$E_J=E_0\sqrt{2\pi(2J+1)}\,i^J;\quad b_\sigma=\left(\chi+i\sigma\sqrt{\varepsilon\mu-\chi^2}\right)/\mu;\quad k_\nu=\left(\sqrt{\varepsilon\mu-\chi^2}+\nu\alpha\right)\omega/c.$$

The boundary conditions for the electric and magnetic fields at the interface between two media yields a system of algebraic equations for the expansion coefficients from which one can determine the coefficients $f^J_{\sigma\nu}$ and $g^J_{\sigma\nu}$ of the scattered and internal fields.

To obtain the scattering and extinction cross sections one should use the Pointing vector for the field outside the scattering particle, it may be written as

$$\vec{S}=\mathrm{Re}\left[\vec{E},\vec{H}^*\right]=\vec{S}^{in}+\vec{S}^{sct}+\vec{S}^{ext};\tag{3}$$

$$\vec{S}^{ext}=\mathrm{Re}\left\{\left[\vec{E}^{in},\vec{H}^{sct*}\right]+\left[\vec{E}^{sct},\vec{H}^{in*}\right]\right\};\ \vec{S}^{sct}=\mathrm{Re}\left[\vec{E}^{sct},\vec{H}^{sct*}\right];\ \vec{S}^{in}=\mathrm{Re}\left[\vec{E}^{in},\vec{H}^{in*}\right],\tag{4}$$

where $\vec{S}^{in}$ ($\vec{S}^{sct}$) is the Pointing vector of the incident (scattered) field and $\vec{S}^{ext}$ is the term due to the interaction between the incident and scattered waves. The energy flux trough a sphere of radius $r>R$ $\left(\Phi^{abs}=-\int\vec{S}d\vec{\sigma}\right)$ may be written as the sum

$$\Phi^{abs}=\Phi^{in}-\Phi^{sct}+\Phi^{ext};\quad \Phi^{sct}=\int\vec{S}^{sct}d\vec{\sigma};\ \Phi^{ext}=-\int\vec{S}^{ext}d\vec{\sigma};\quad \Phi^{in}=-\int\vec{S}^{in}d\vec{\sigma}.\tag{5}$$

The Pointing vector's modulus of the incident wave is $\mathrm{I}^{in}=\left|\vec{S}^{in}\right|=\mu^{-1}\sqrt{\varepsilon\mu-\chi^2}\,E_0^2$.

The scattering and extinction cross sections are obtained in the following forms:

$$\sigma_\nu^{sct} = \frac{\Phi^{sct}}{\mathrm{I}^{in}} = 4\pi\sum_{J=1}^{\infty}\left(2J+1\right)\sum_{\sigma=\pm1}\left|f_{\sigma\nu}^{J}\right|^2\frac{1}{k_\sigma^2}; \qquad (6)$$

$$\sigma_\nu^{ext} = \frac{\Phi^{ext}}{\mathrm{I}^{n}} = 2\pi\sum_{J=1}^{\infty}\left(2J+1\right)\sum_{\sigma=\pm1}\mathrm{Re}\left[f_{\sigma\nu}^{J}\left(1+\sigma\nu\right)/k_\sigma k_\nu\right]. \qquad (7)$$

The results for the scattering cross section (6) and extinction cross section (7) obtained have been studied by numerical calculations performed in the Mathematica system (fig.1). At the electromagnetic processes describing it is convenient to use the efficiency factor of extinction (scattering), which is defined as the cross section, divided by the particle radius squared (or by πR^2). The dependence of this factor on the parameter R/λ was calculated and this corresponds to the efficiency factor dependence on the radius at a fixed frequency of the incident radiation.

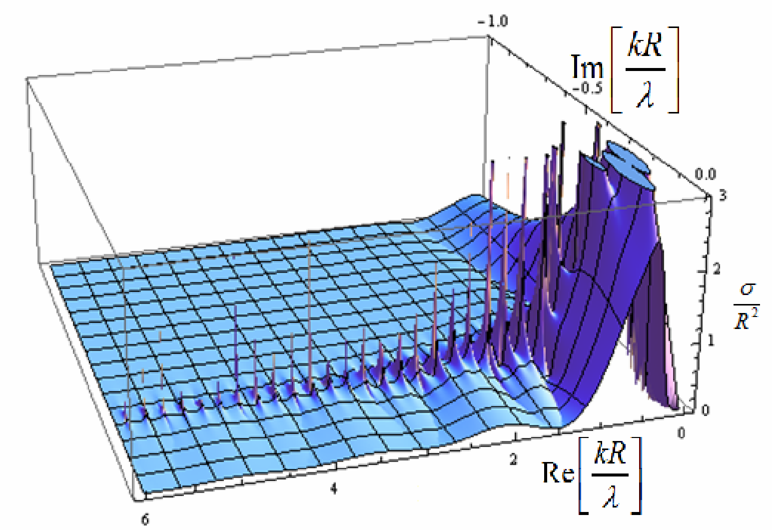

Fig. 1. Plot for the partial extinction cross section on the complex kR -plane:
$\nu=1;\ J=1;\ \chi=0.1;\ \varepsilon=1.1;\ \mu=1;\ \alpha=0.1;\ \chi_1=0.1,\ \varepsilon_1=1.3;\ \mu_1=1.1;\ \alpha_1=0.3.$

In this paper the scattering and extinction cross sections are calculated in the case of the plane circularly polarized electromagnetic wave scattering on a biisotropic sphere embedded in another biisotropic environment. The behavior of individual partial terms of the cross sections is analysed on the complex plane kR . Maximums (fig. 1) can be explained by existence of the poles of the amplitudes $f_{\sigma\nu}^{J}$ near the real kR -axis.

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