PREDICTION OF THE AZIMUTH ANGLE DEPENDENCE OF THE QUASIMOLECULAR ANISOTROPY IN HEAVY ION COLLISIONS ☆

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Within the quasimolecular (MO) kinematic dipole model we predict a strong dependence of the anisotropy of the MO radiation on the orientation of the heavy ion scattering plane relative to the direction of the photon detection plane.

During the last two years various models for the interpretation of the anisotropic X-ray emission in heavy ion collisions have been presented [1–5]. Although these models are very different in their explanation of the anisotropy of the MO X-rays up to now, there exists no experiment which allows to decide which theory seems to be more realistic. Wölfli [6] suggested to measure the X-ray anisotropies as function of the azimuth angle ϕ, which is the angle between the plane defined by the incoming beam and the 90°-photon detection direction and the plane given by the incoming beam and the deflected ion beam. This coincidence type of experiment has to be performed at an X-ray energy where in the non-coincident experiment an anisotropy maximum occurs.

Within the kinematic dipole model (KDA) of the anisotropy [5] we have performed ϕ dependent calculations for various heavy-ion scattering systems at various impact energies and different transitions. It has to be mentioned here that in the present form of the KDA model we do not sum over the transition amplitudes along the trajectory as it should be done but over the intensities. This incoherent summation is expected to be a good approximation for the M and L MO X-rays where many transitions contribute to the spectrum and where the same transition often has the same energy at different internuclear distances [5]. So the large number of interferences is expected to cancel each other. We must admit, that the incoherent summation may be no good approximation for K MO X-rays where only a few transitions contribute, so that the interferences may easily occur. But this more accurate prediction of the azimuth angle dependence of the anisotropy can only be made for the specific system, impact energy and X-ray energy.

Because of the incoherent summation in the KDA model the spectral behaviour and ϕ dependence of the anisotropy always has the same general structure; only the magnitude depends very much on the system and initial conditions.

Fig. 1 shows the general feature of the calculated anisotropy spectra for different azimuth angles ϕ = 0°, ..., 90° taking into account the integration along each trajectory and over all impact parameters in the collision plane. It shows a decrease of the absolute values of the anisotropy and a decreasing peak structure behaviour.

Fig. 2 shows the anisotropy as function of the azimuth angle ϕ itself at an X-ray energy with a maximum in the anisotropy spectrum.

While most of the other models predict a constant behaviour of the anisotropy as function of the scattering plane, our model exhibits a very strong angular dependence which shows symmetry properties due to the symmetry of the scattering process and the single transition radiation pattern. The maximum of the anisotropy is at ϕ = 0° and the minimum at ϕ = 90°.

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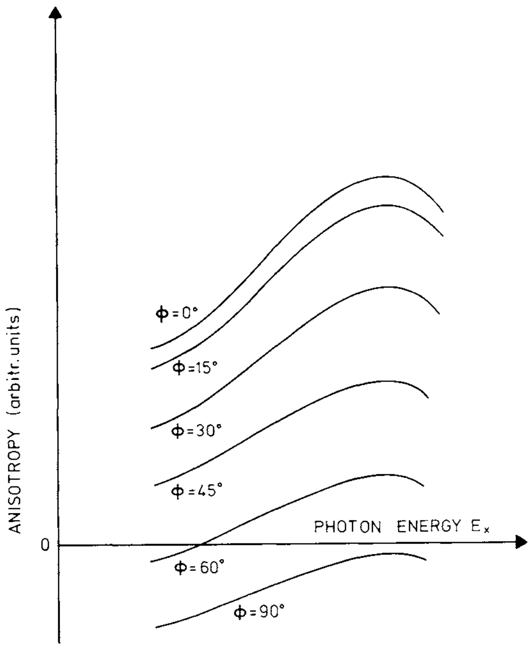

Fig. 1. Change of the peak structure of the anisotropy spectrum with the azimuth angle ϕ as a parameter. The general behaviour is a decrease of the peak maximum.

Concerning the quality of anisotropy calculations, coincidence experiments with fixed scattering planes are a crucial test for further development of MO-radiation theories. This type of experiment should be the next step forward in the investigation of inner shell phenomena in heavy ion collisions.

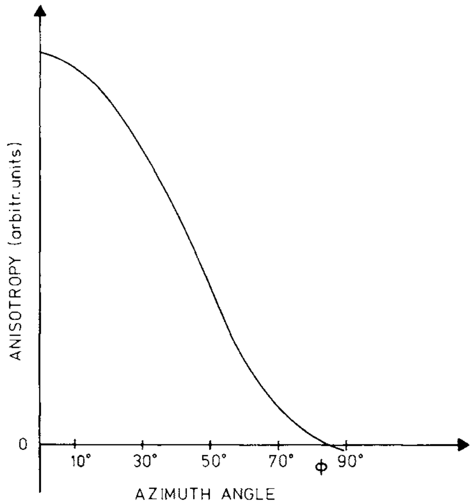

Fig. 2. The anisotropy as function of azimuth angle ϕ at an energy at a maximum in the anisotropy spectrum. The general feature given here is a maximum at $\phi = 0°$ and a minimum at $\phi = 90°$.

References

[1] J.S. Briggs and K. Dettmann, J. Phys. B10 (1977) 1119.
[2] M. Gros, P.T. Greenland and W. Greiner, Z. Phys. A280 (1977) 31.
[3] W. Däppen, Thesis ETH Zürich, unpublished (1977).
[4] R. Anholt, Z. Phys. A288 (1978) 257.
[5] H. Hartung and B. Fricke, Z. Phys. A288 (1978) 345; H. Hartung, B. Fricke, T. Morović, W.-D. Sepp and A. Rosén, J. Phys. B (1979), to be published.
[6] W. Wölfli, private communication.