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World Congress on Medical Physics and Biomedical Engineering

Tentative-Program

7. July - 12. July, 1991

Kyoto International Conference Hall

THE INTERPRETATION OF THE LIGHT SCATTERING BY ELLIPSOIDAL RED BLOOD CELLS IN EKTACYTOMETRY: FRAUNHOFER VERSUS ANOMALOUS DIFFRACTION

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The mechanical properties of red blood cells are of great importance for the rheological behavior of blood in the circulation. The excellent deformability of the red blood cells implicate a relatively low viscosity of the blood and guarantee the passage of the cells through the micro circulation.

In order to quantify red cell deformability, ektacytometry is one of the techniques commonly used. In an ektacytometer, a laser beam is sent through a sheared suspension of red blood cells. The Couette flow between two coaxial transparent cylinders causes the red cells to deform and transform into ellipsoids. The resulting elliptical intensity pattern is projected on a screen and can be related to the deformation of the ellipsoidal cells.

A[illegible]et, Fraunhofer diffraction is exclusively used to describe this pattern. Calculations on a spherical model of the red cell (radius 3.9 μm) however show that this theory deviates significantly from the exact Mie theory. It can be shown that this deviation is mainly caused by neglecting the phase shifted light traversing the cells. Anomalous diffraction as introduced by v.d. Hulst does incorporate the phase shifted light and is found to be a much better approximation of the Mie theory.

An expression for the intensity distribution of the light as scattered by ellipsoidal red cells is derived using the anomalous diffraction approach. In this expression, the direct relationship between the shape of the red cells and the intensity distribution of the scattered light is shown.

The expression is fitted on the intensity distribution caused by the sheared red cell suspension and is found to describe the measurements satisfactory.

The Anomalous diffraction theory is proofed to describe the small angle light scattering in ektacytometry correctly and is an useful tool in the physical interpretation of the intensity pattern.