

# A Hands-on "View" of microKosmos

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**Abstract.** Hands-on "view" of microKosmos, with the structure, the interactions and the movements of microscopic wave-particles are presented. This view is achieved by a simulation / animation hands-on computer program with the use of Monte Carlo methods / techniques since microKosmos is eminently a stochastic system. Furthermore, microKosmos is the part of the world where the wave-particle duality comes up vigorously and such computer simulations / animations may wipe out some students' misconceptions and clarify some quantum "paradox" such as the paradox of wave-particle duality. With this "view" of microKosmos an imaginary journey into the interior of the matter can be attempted offering students (and teachers as well) the opportunity to have a glimpse to the microKosmos processes which can explain to them most of the macroscopic concepts and phenomena.

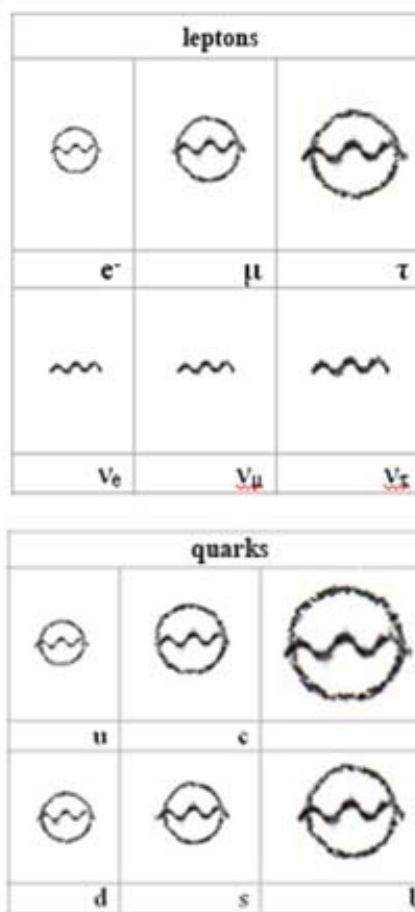
**Keywords.** Animation, microKosmos, Micro-processes, Monte Carlo methods / Techniques, Simulation, Wave-particles

## 1. Introduction

The structure, the interactions and the movements of microKosmos –from the "a-toma" / superstrings (;) to molecules– are simulated / animated by a hands-on computer program with the use of Monte Carlo methods / techniques since microKosmos is eminently a stochastic system. Monte Carlo Methods, in general, can be described as statistical methods involving sequences of random numbers to perform various calculations. Monte Carlo Techniques, in use, employ those methods in order to simulate / animate by the computer certain stochastic processes according to specific distributions. Concerning the modelling and simulation / animation parts of the procedure may offer a view, even a glimpse, to the details of the

complex realistic systems operation of microKosmos with a pedagogical virtue. Furthermore, this characteristic of Monte Carlo simulation / animation programs is one of the characteristic which "legitimate" the use of computers to physics education.

On the other hand, microKosmos is the part of the world where the wave-particle duality comes up vigorously and such computer simulations / animations may wipe out the impression / misconception of the students that "quantum mechanics is just incomprehensible" and clarify some quantum "paradox" such as the paradox of wave-particle duality.

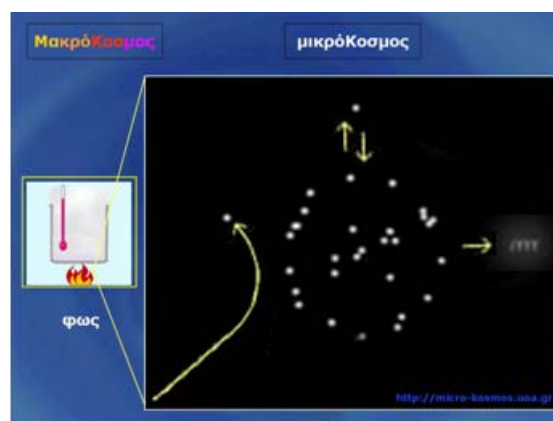
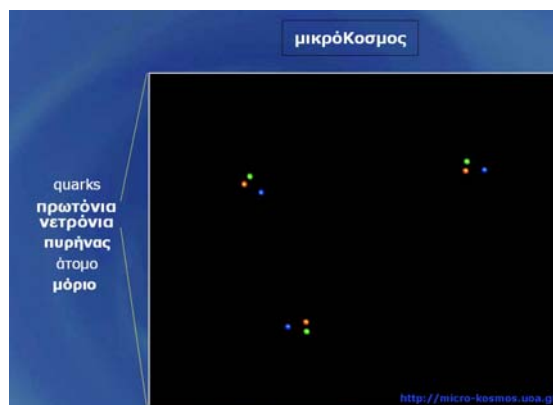


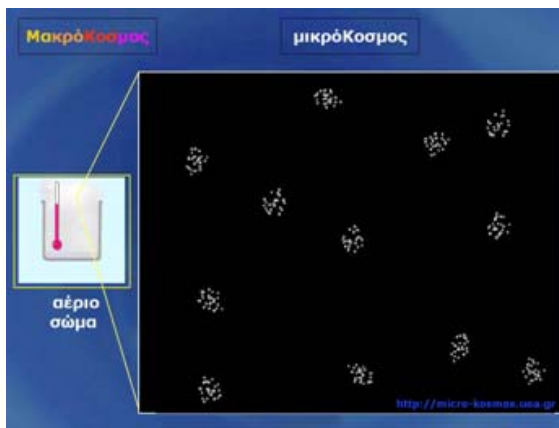
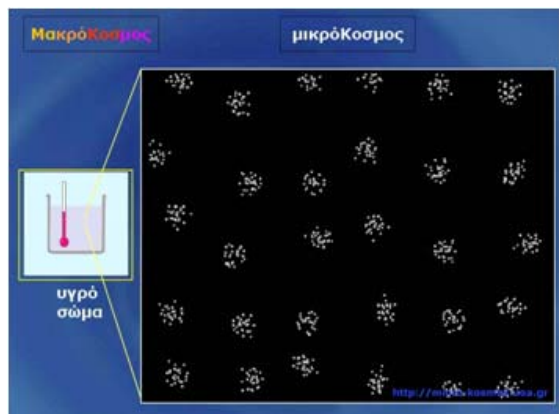
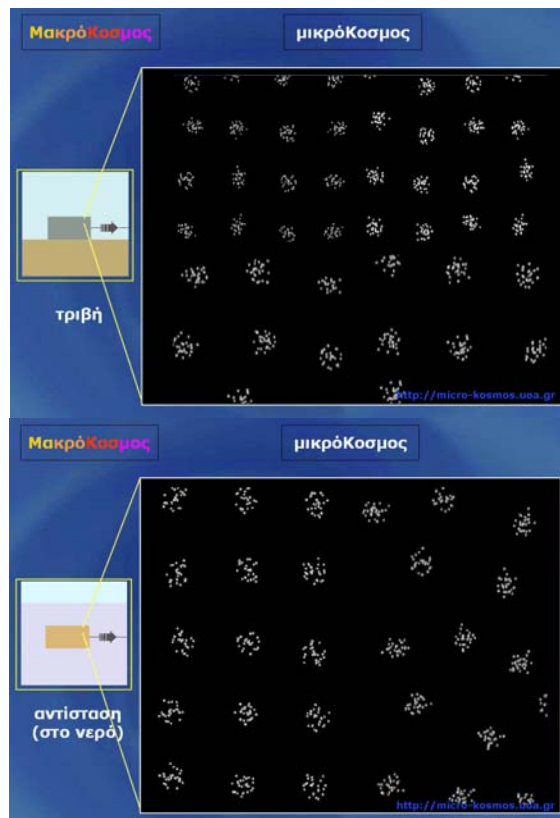
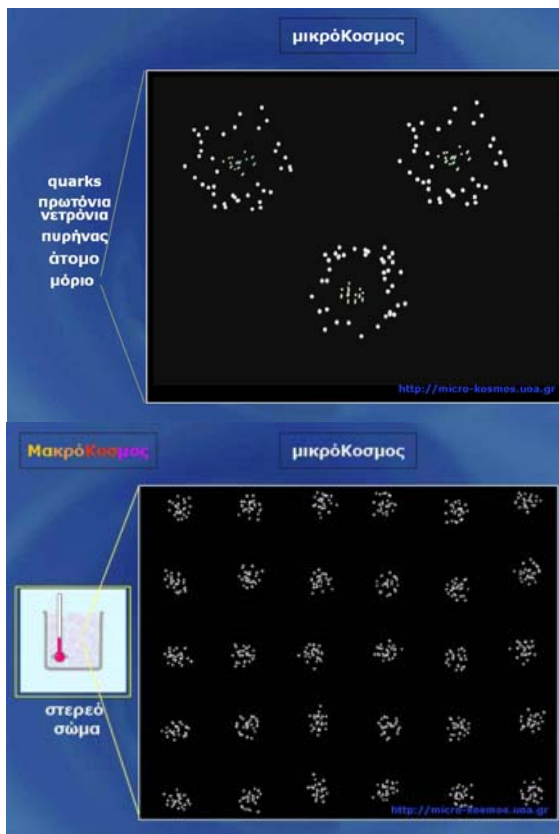
The wave-particles are visualised in the animation program by successive images of a

wavepulse (which sometimes is shown and sometimes is not shown) and a particle (according to the model of elastic spheres) without any display of track, whilst they are visualised in static images by overlapped wavepulses and circles.

With these "views" of microKosmos an imaginary journey into the interior of the matter can be attempted offering students (and teachers as well) the opportunity to have a glimpse to the microKosmos processes which can explain to them most of the macroscopic concepts and phenomena (e.g. excitation–relaxation of atom's electrons / emission of photons, molecules' interactions / rigidity of solids, molecules' thermal motion / expansion-contraction of matter, molecules' motion / fluidity of liquids and gasses, molecules' movements / static pressure / friction, ...). The hands-on operation of an improved version of this computer simulation / animation program may offer the opportunity to the students and teachers as well to change / select the parameters of the desired views of the microscopic processes (number of wave-particles, interactions, motion, ...) in order to correspond / fit with certain macroscopic phenomena.

## 2. Static images of simulated / animated wave-particles





### 3. Acknowledgements

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