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Selected Contributions

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ON THE TRACK OF MODERN PHYSICS

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1 ON THE TRACK OF MODERN PHYSICS

Introducing concepts of modern research into secondary schools brings the risk that Physics drifts towards phenomenological description rather than a logical construction of our knowledge on the Nature. A typical example is the question on elementary particles: “Can we divide the matter into infinitely small parts?” “Are quarks a really indispensable (and experimentally proved) proved reality or just another step in dividing the matter?”

Quarks as small balls in three possible colours are a common picture. We propose them as small animals, with dimension corresponding to their mass (and tails up or down). However, this would a misleading simplification if exact information on their mass (with the error bar on this estimate), the experiments in which they were discovered and ways in which they form other “elementary particles” like hyperons, charmonium etc. is not given. We do it in a series of poster available on internet [1].

Separate posters forming a didactical unity on quarks are entitled:

1) “Enigmatic quarks”- with quark-animals, their masses neutron, proton and hyperon
2) “Super-multiplets” – showing way to deduce on quarks existence, with James Joyes jokes
3) “How to find a quark”: you need an accelerator and some luck; historical experiments
4) “Charm of charmonium” – exact reproduction of papers around the discovery of *c*-quars

An essential point in bringing such complex and various contents into schools is to catch the attention. We do it by jokes, surprising conclusions, and picturesque associations of ideas. For more details we refer the reader to our previous GIREP report [2].

However, Modern Physics is spectacular in elementary particle discoveries, but much more of the practical impact in other sectors, like mass and optical spectroscopy, atomic physics, and material science. In “On the track of Modern Physics” we show interesting examples of this, “soft” physics. One of them is the

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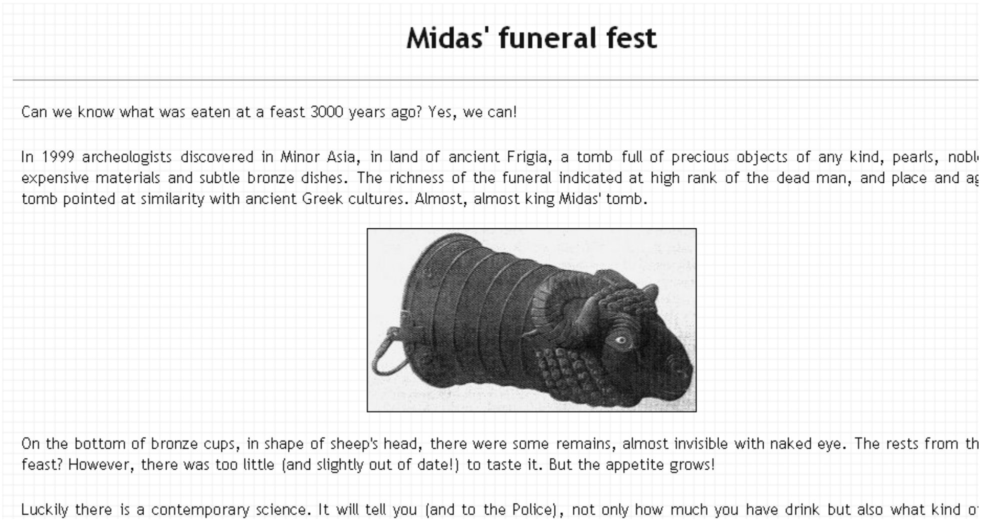
spectroscopy of food remains from a tomb in Middle Turkey, from 7th century B.C. (see Figure 1).



Midas' funeral fest

Can we know what was eaten at a feast 3000 years ago? Yes, we can!

In 1999 archeologists discovered in Minor Asia, in land of ancient Frigia, a tomb full of precious objects of any kind, pearls, nobl expensive materials and subtle bronze dishes. The richness of the funeral indicated at high rank of the dead man, and place and ag tomb pointed at similarity with ancient Greek cultures. Almost, almost king Midas' tomb.

On the bottom of bronze cups, in shape of sheep's head, there were some remains, almost invisible with naked eye. The rests from th feast? However, there was too little (and slightly out of date!) to taste it. But the appetite grows!

Luckily there is a contemporary science. It will tell you (and to the Police), not only how much you have drink but also what kind o

Figure 1 "Midas funeral feast" – a piece of story on the mass spectroscopy applied to archeology, from [1].

Teaching Quantum Mechanics is usually limited to telling about some matter-wave phenomena and showing interference patterns. The discovery of the minimum in the total cross section for electron scattering on argon at about 0.4 eV by Ramsauer and in a complementary experiment by Townsend in 1921, i.e. just before de Broglie's hypothesis showed a need to treat particles as waves. A theory to explain the Ramsauer effect came in 1929 by solving Schrödinger equation by Holts and Holtsmark.

In wave mechanics, the differential cross section $d\sigma/d\omega$ equals the square of the "scattering amplitude" f

$$\frac{d\sigma}{d\omega}(\theta) = |f(\theta)|^2 \ .$$

The scattering amplitude is given by:

$$f(\theta) = \frac{1}{2ik}\sum_{\ell=0}^{\infty}(2\ell+1)\left(\exp(2i\eta_\ell)-1\right)P_\ell(\cos\theta) \ ,$$

where $\hbar\ell$ is the angular momentum in the collision, ℓ = 0, 1, 2, … . η_ℓ are the "phase shifts" of the respective partial waves and $P_\ell(\cos\theta)$ are Legendre polynomials. The mathematics behind these calculations can be easily done by excel software [6]. It turns be very didactical how changing phase shifts (by software sliders" changes in a complex way the angular distribution of scattered electrons (or positrons, as on a real research example shown in Fig. 2).

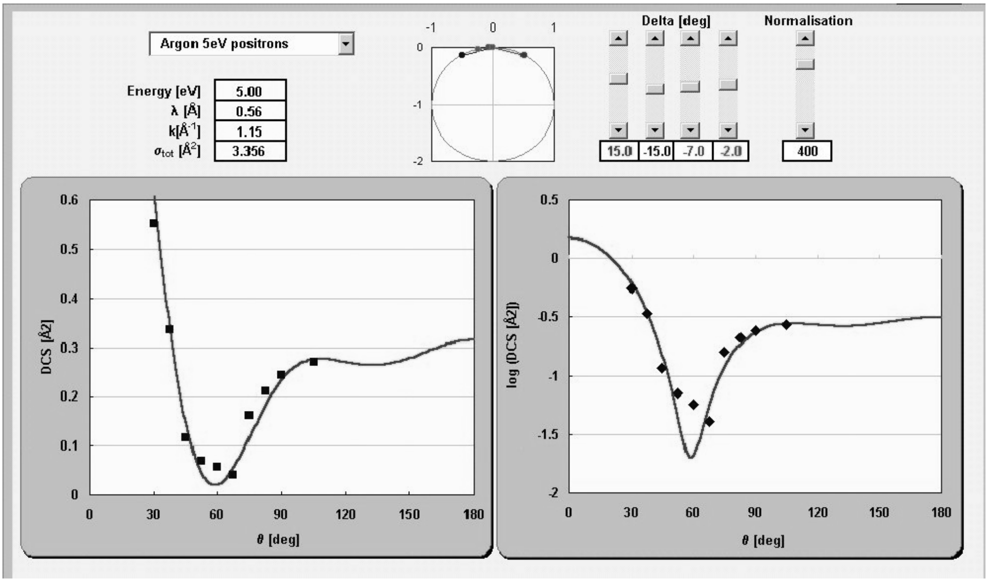


Figure 2 Excel program to calculate angular distributions of scatter positrons via complex number algebra [6].

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