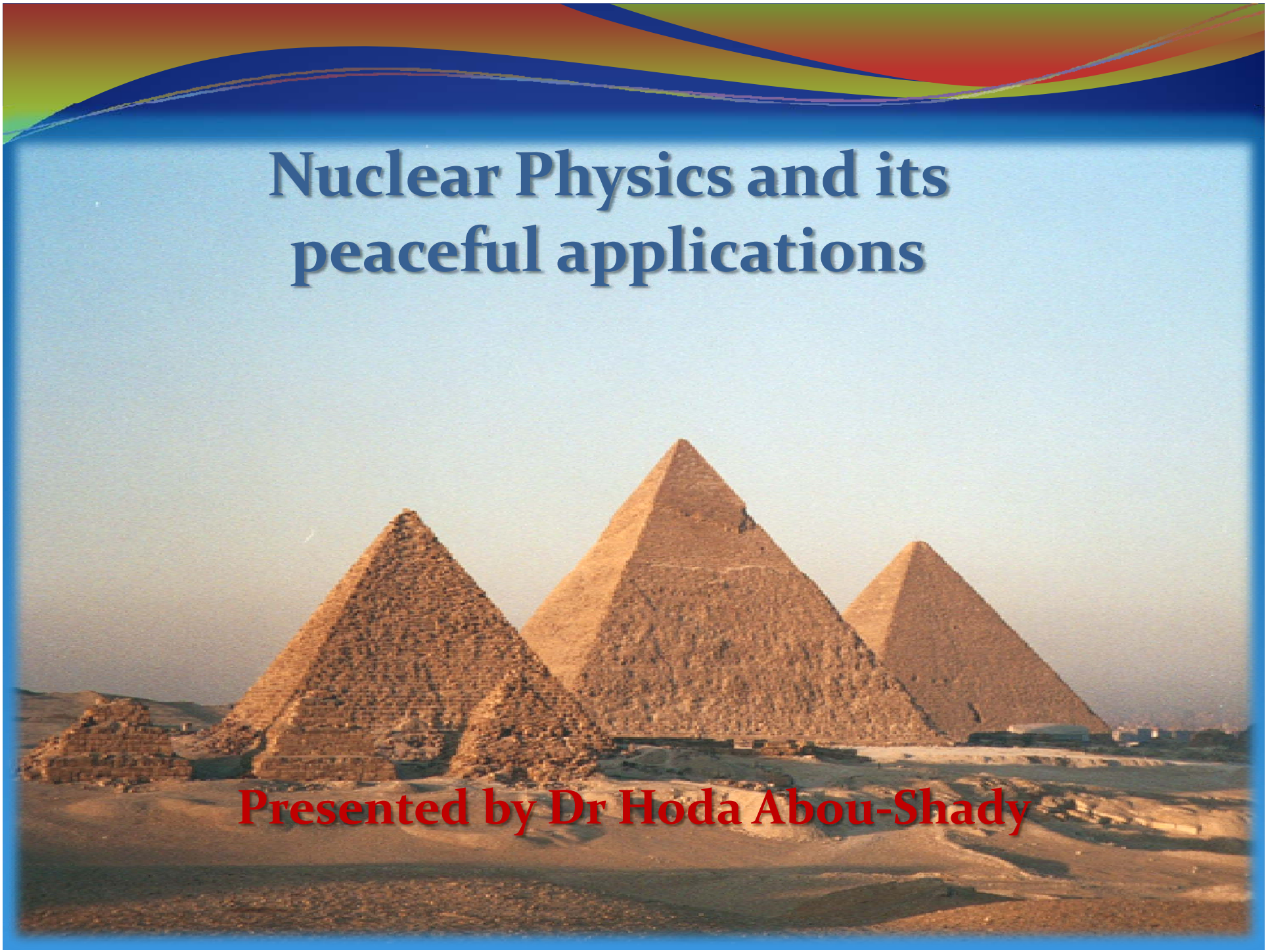
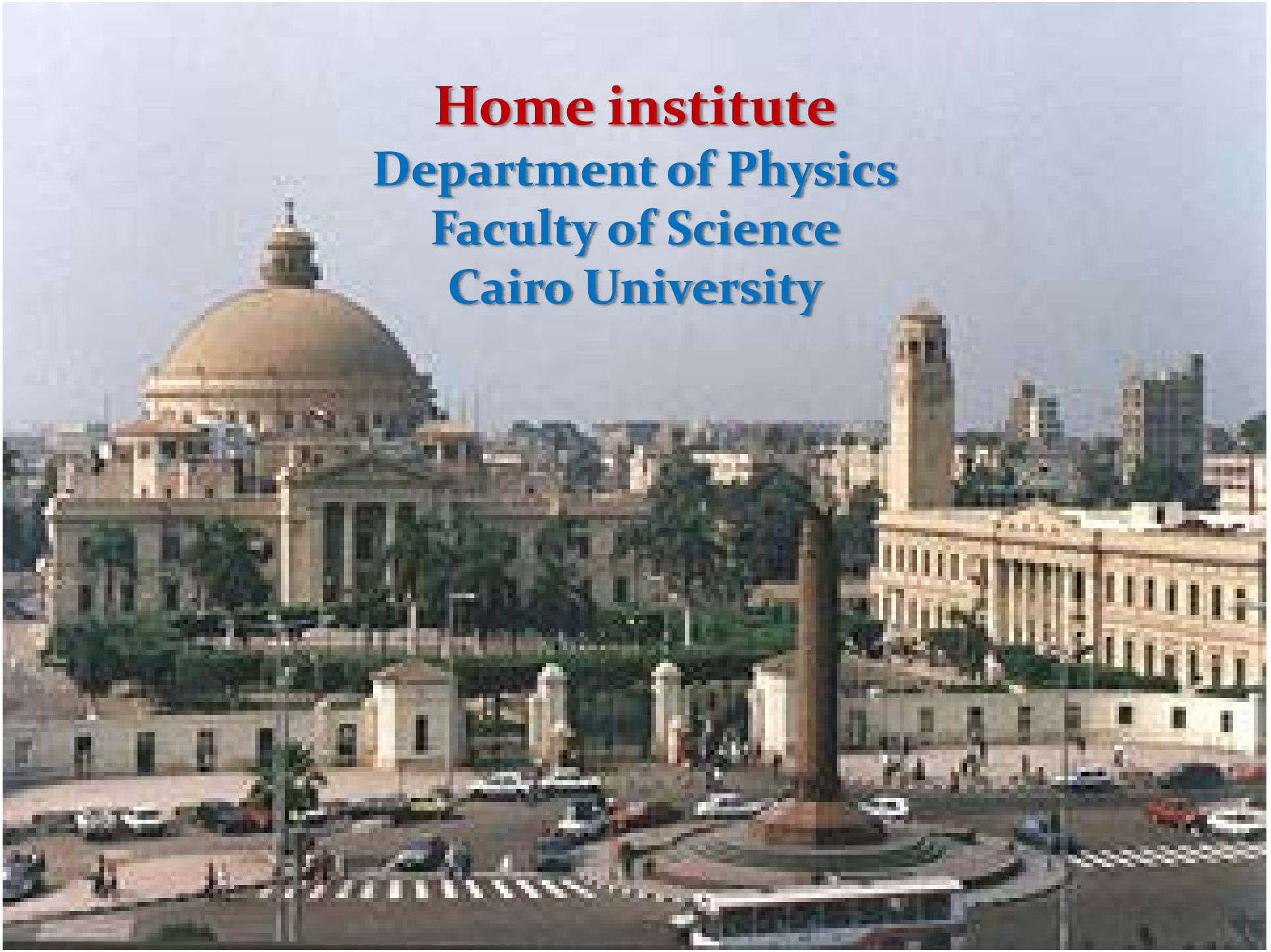
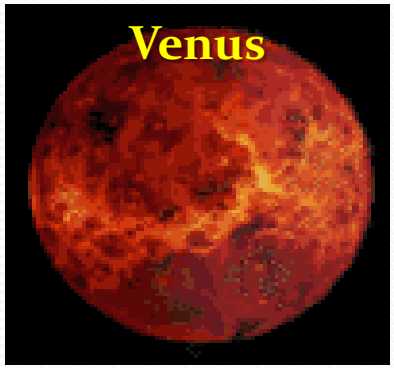
Nuclear Physics and its peaceful applications



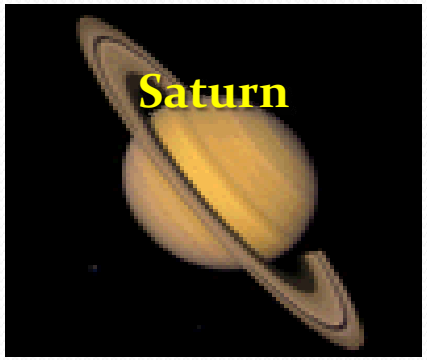
Presented by Dr Hoda Abou-Shady


Home institute
Department of Physics
Faculty of Science
Cairo University

Themes of research in nuclear physics



Theoretical nuclear physics



Nuclear engineering

Experimental nuclear physics

Theoretical nuclear physics

Main Research interest: Deformed Nuclei

Main Research calculations:

Reaction Cross section

- Variation with different deformation and orientation
- Max σ
- Min σ
- Av σ over all orientation

Fusion cross section

- Variation with deformation and orientation
- Variation of barrier parameters
- Barrier distribution
- Average over all Orientation

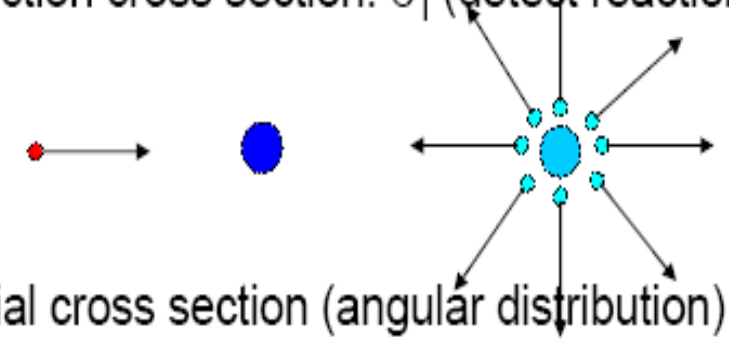
Differential cross section

- Glauber theory
- Eikonal approximation
- Comparison with other theoretical models
- Halo nuclei

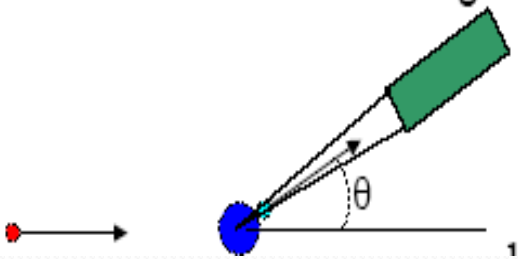
Cross sections?

- **To characterize the probability that a particular nuclear reaction will take place, or the statistical nature of scattering events**

- Total reaction cross section: σ_T (detect reaction products in 4π)



- Differential cross section (angular distribution) $\frac{d\sigma}{d\Omega}$: (detect only reaction products emitted at θ within a solid angle $d\Omega$)



- **The total reaction cross section within the optical model calculation, is defined as the total cross section σ_T minus the elastic σ_{el} cross section for nucleus-nucleus reactions:**

$$\sigma_R(\beta,\hat{\Omega}) = 2\pi\int_0^{\infty}\{1 - Exp[i\chi(b,\Omega)]\}bdb$$

Ω, β are the symmetry axis direction and the target nucleus deformation parameters

- **χ(b, Ω) is the profile function defined**

$$\chi'(b,\hat{\Omega}) = \int_{-\infty}^{\infty} dz \int \rho_T(\vec{r},\hat{\Omega})\rho_p\left(\left|\vec{r} - \vec{R}\right|\right)\sigma_{NN}\left(\rho_T + \rho_p, \frac{E_L}{A_P}\right)d\vec{r}$$

- **ρ_T and ρ_P are the densities of the target and projectile and R is the separation distance between their centers and E_L/A_p is the incident energy per projectile nucleon in the lab system and σ_{nn} is the nucleon nucleon cross section.**

- The deformed target density distribution is given by

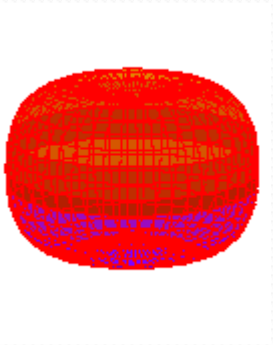
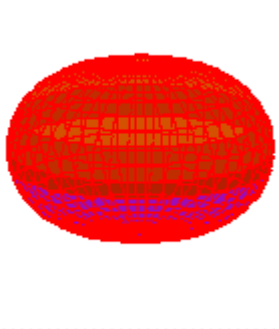
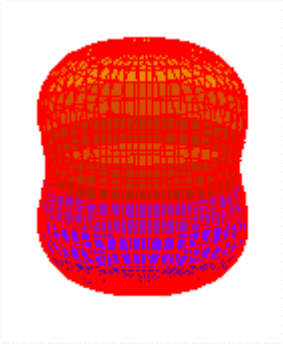
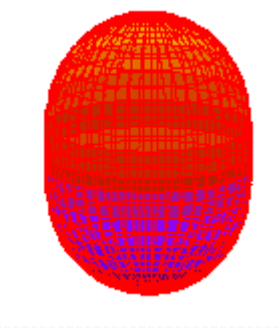
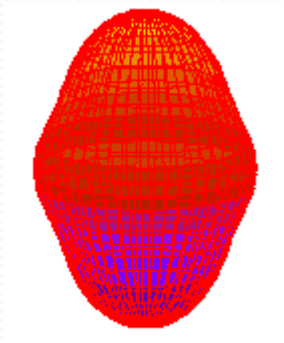
$$\rho_T(\vec{r},\hat{\Omega}) = \frac{\rho_o}{1+e^{\frac{r-R(\theta_1)}{a}}}$$

- Where R is the half density radius

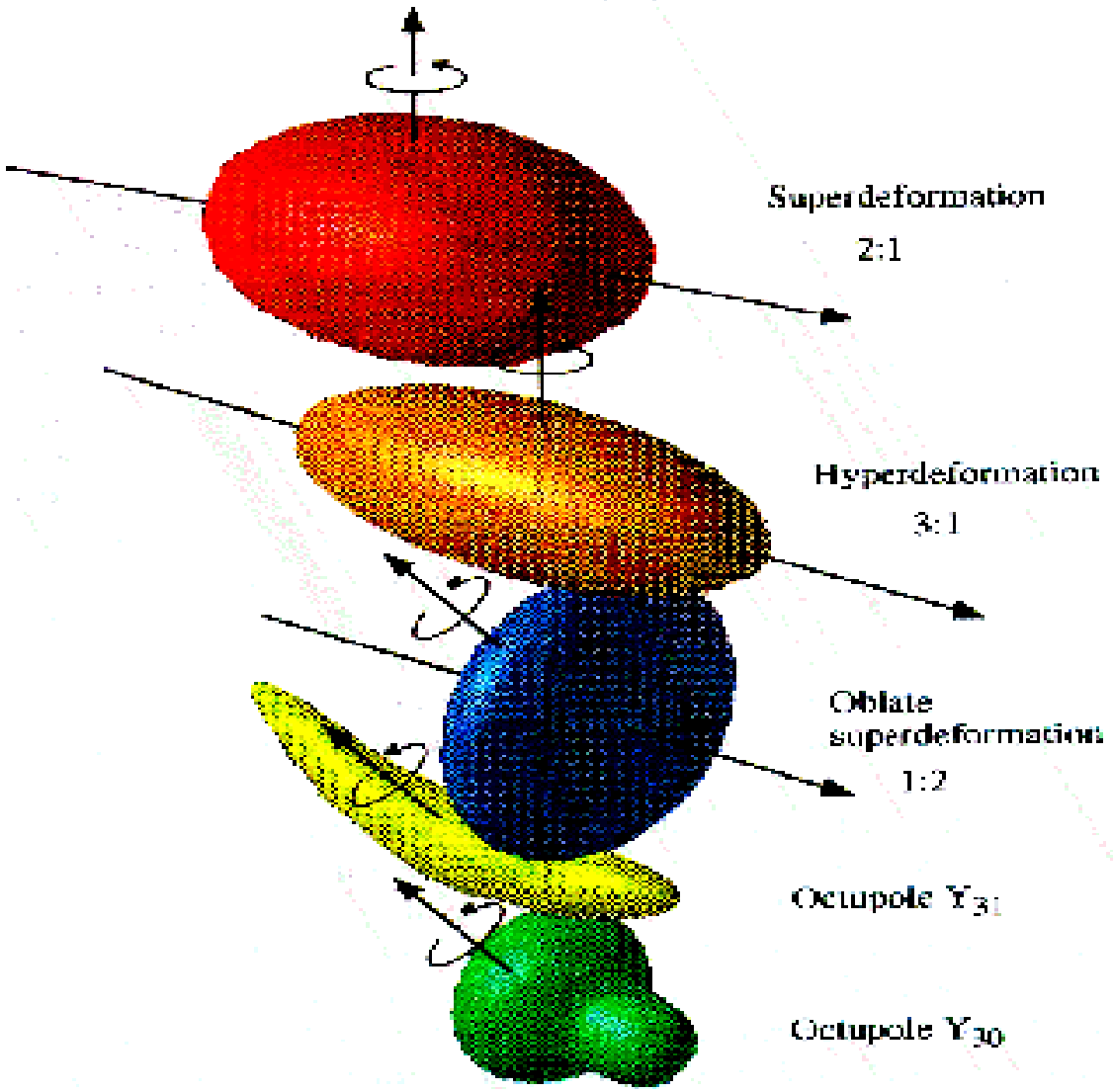
$$R_o(\theta_1) = R_o[1+\beta_2 Y_{2o}(\theta_1)+\beta_4 Y_{4o}(\theta_1)+\beta_6 Y_{6o}(\theta_1)]$$

- Where β_2, β_4 and β_6 account for quadrupole, hexadecapole and hexacontatetrapole deformation parameters as shown in the upcoming figures

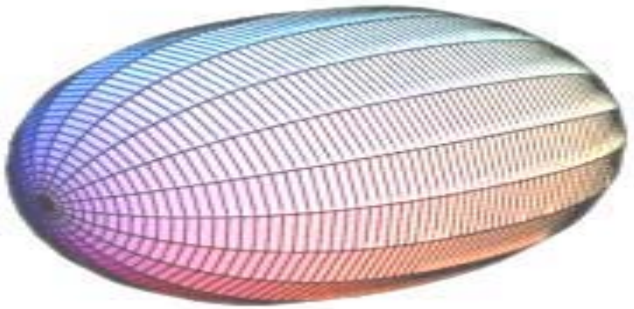
The actual shape of the Lithium-7 nucleus

	β4 = -0.2	β4 = 0	β4 = 0.2
β2 = -0.4			
β2 = 0.4			

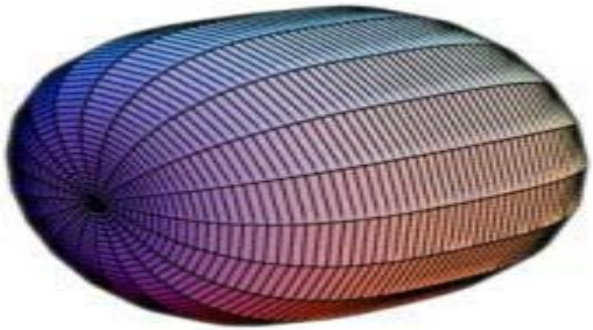
Types of deformation



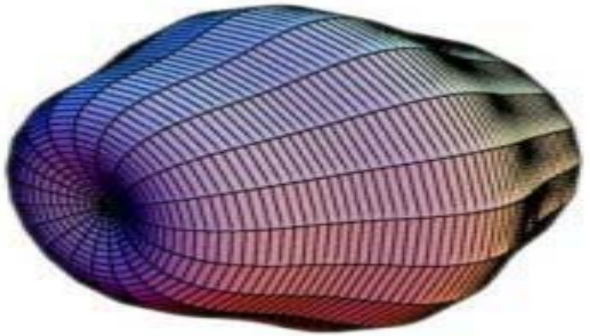
- **Quadrupole**
  (β_2=> 4 moment)



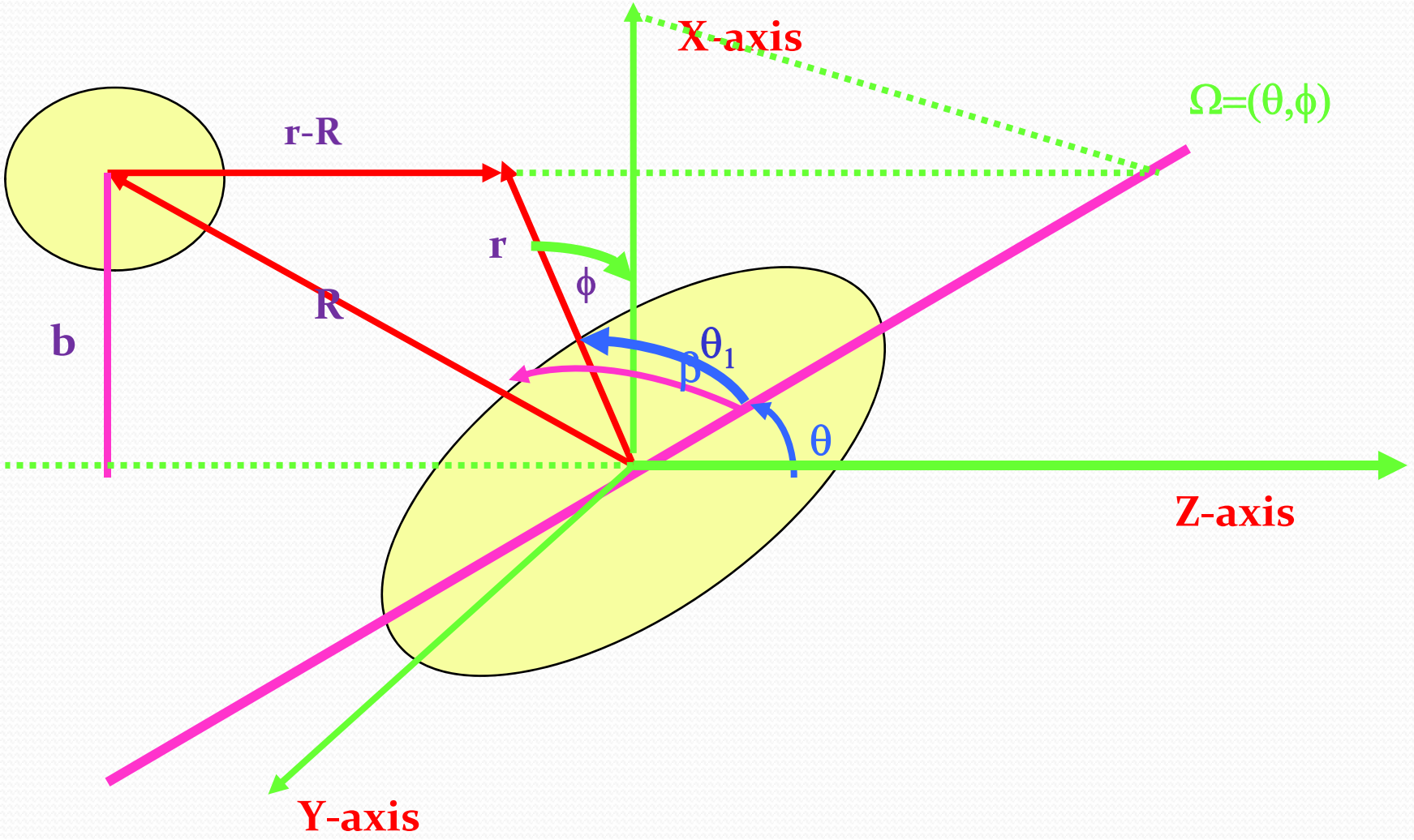
- **Hexadecapole**
  (β_4=> 16 moment)



- **Hexacontatetrapole**
  (β=6=> 64 moment)



Schematic representation of the collision between deformed target and spherical projectile nuclei, R is in the x-z plane



Part of Publications

- Translation of Volume IV of L'université de tous les savoirs, part "des particules a l'antimatière : la matière et son organization " from French to Arabic for the supreme council of culture and the French cultural center in Egypt 2007
- Study of Coulomb force for two diffuse spherical deformed nuclei, Physics of Atomic Nuclei 2006, Vol. 69, No. 9, pp.1463–1471., M. Y. Ismail, Ahmed Bakri, W. Seif, H. Abou-Shady Optical fiber instability during coating process; journal of fluid and structure 22 (2006), pp 599-516. M. Hamadich, H. Abou-Shady
- Geometric Interpretation of the reaction cross section for Deformed-Spherical interacting pair, the Egyptian journal of physics vol 37, no2 p171-182(2006), M. Y. Ismail, H. Abou-shady, H. El- Gebaly, A. Ellithi.
- Effect of finite range NN force and NN cross section on reaction cross section for neutron rich nuclei. Physical review C71 (2005) 027601. M. Y. Ismail, A. Ellithi, H. Abou-Shady.
- Effect of β_6 deformation parameter on fusion cross-section and barrier distribution, Acta Phys. Hung. A21 (2004) 27 – 38, Ismail; M.M. Osman; H. El Gebaly ; H. Abou-Shady.
- Calculation of the reaction cross section of the $C^{12}+N^{17}$ using relativistic heavy ion potential single author, Egyptian Journal of Physics, Vol. 25 June 2004, H. Abou-Shady
- Orientation and deformation dependence of the reaction cross-section for a deformed target nucleus, Modern physics letters vol.18 no.1 (2003), Ismail; M.M. Osman; H. El Gebaly; H. Abou-Shady

Experimental nuclear physics

- Egyptian atomic energy authority
- Graduate courses in Egyptian universities only

Are we prepared for a nuclear power plant?

- Nuclear engineering (1 university, no experimentation)
- Nuclear courses (needs renovation)
- Public recognition (urban myths)

Center of excellence for nuclear graduate studies and its peaceful application

1) Incubator for young researchers and graduate students
2) Provide basic courses for nuclear engineers
3) Fission and fusion in action
4) Nuclear pharmaceuticals
5) Desalination and health physics
6) Neutron activation analysis

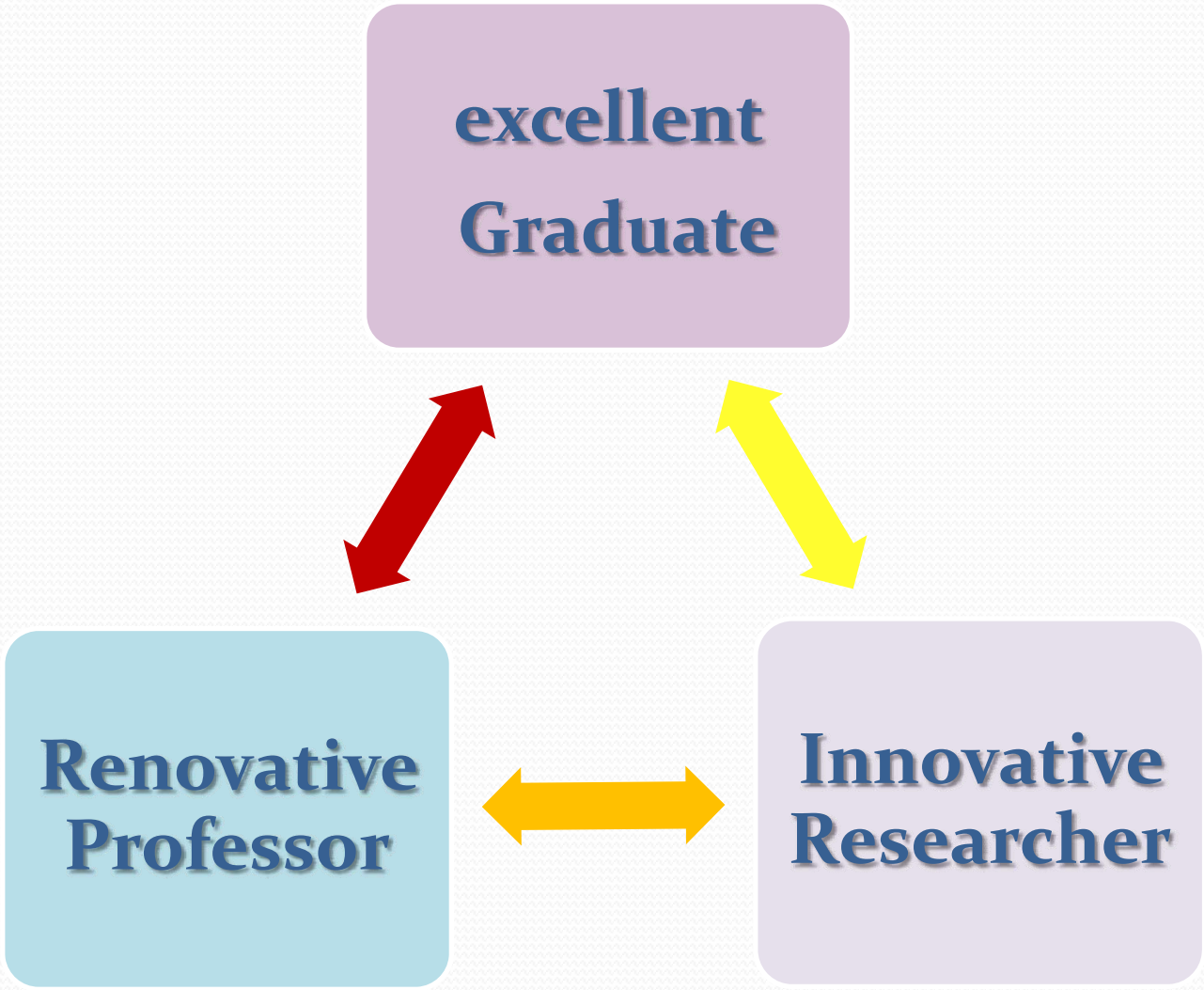
•Sharing knowledge

- France
- Italy
- ICTP
- IAEA

•Starting from scratch

- Korea
- India
- Pakistan

Cycle of excellence



Thank you

The Rhind Papyrus 2000B.C