



# SUPERDIFFUSION AND AUGER THERAPY PRODUCED WITH X-RAYS


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- ▶ The X-rays influence on NaCl, KCl very fast crystallization in a saturated water solution and introduction of phosphorus, boron and carbon in crystal silicon at room temperature.
  - ▶ These new technologies or superdiffusion based on of impurities introduction do not harm the Si lattice and can be used for production of a new kind electronics devices and solar cells of high quality.

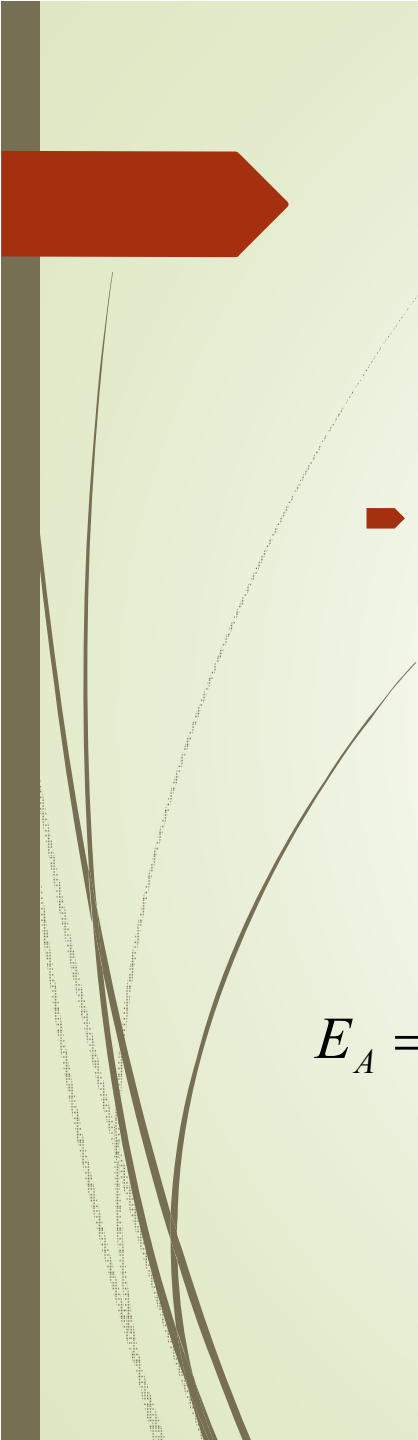
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- Similarly superdiffusion based on Auger effect generate electrons of low kinetic energy which damage cells of body over a very short range in DNA by cancers' therapy.
  - It is more progressive method than radiation therapy by ions or protons with energies about 100 MeV from accelerators which damage the cells by irradiation for therapy of tumor and metastasis.

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- ▶ Low energies Auger electrons 10 – 20 eV or initial photons of X-ray 10-20 keV damage DNA or its components but not single cell what reduce probability its killing.




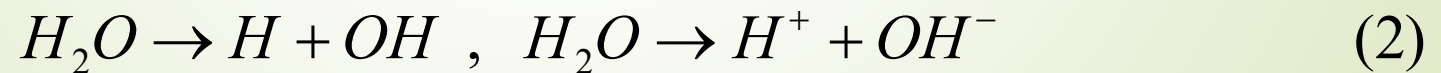
# Introduction

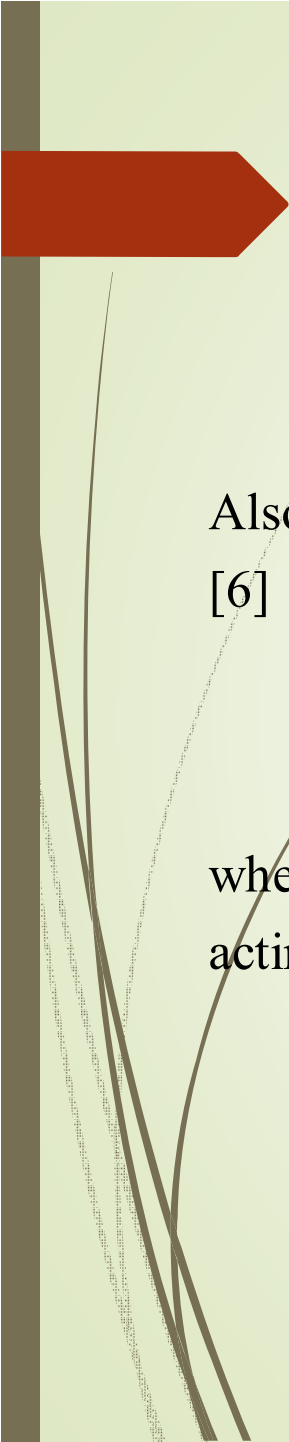
- ▶ We applied soft X-rays for generation of metastable vacancies in a Si crystal [1], [2]. This is sufficient for practical realization of new kind of superdiffusion [1], for introduction of boron and phosphorus in crystal silicon [3], [4] at room temperature.
- ▶ The proposed technologies do not harm the Si lattice because for displacement of impurities atoms in crystal silicon is used Auger effect taking part in displacement of only one crystal's lattice's atom with energies 10-20 eV what can be used for production of electronic devices with less defects and new materials.

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- ▶ Also it is important that energies of Augers electrons do not depend on energies of particles or photons producing vacancies in shells with greatest binding energies of electrons in atoms. Energy of emitted electron depends of initial vacancy and vacancies from spontaneous transitions of external electrons

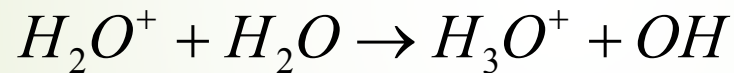
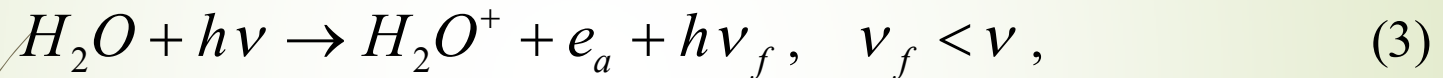
$$E_A = E(a^{-1}) - E(b^{-1}c^{-1}) \quad (1)$$

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- ▶ The changing energy of monochromatic X-rays we can induce the inner-shell ionization and change energies of Auger electrons. By photoelectric reactions in body cells can be generated dissociation reactions of water molecules [5], [6]






Also photon produces the hydrated electrons  $e_a$  and unstable radicals  $H_2O^+$   
[6]



where weakly bounded metastable radicals  $H_3O^+$  are produced. Its interactions acting like collectors of negative ions eliminate water ionization in cells



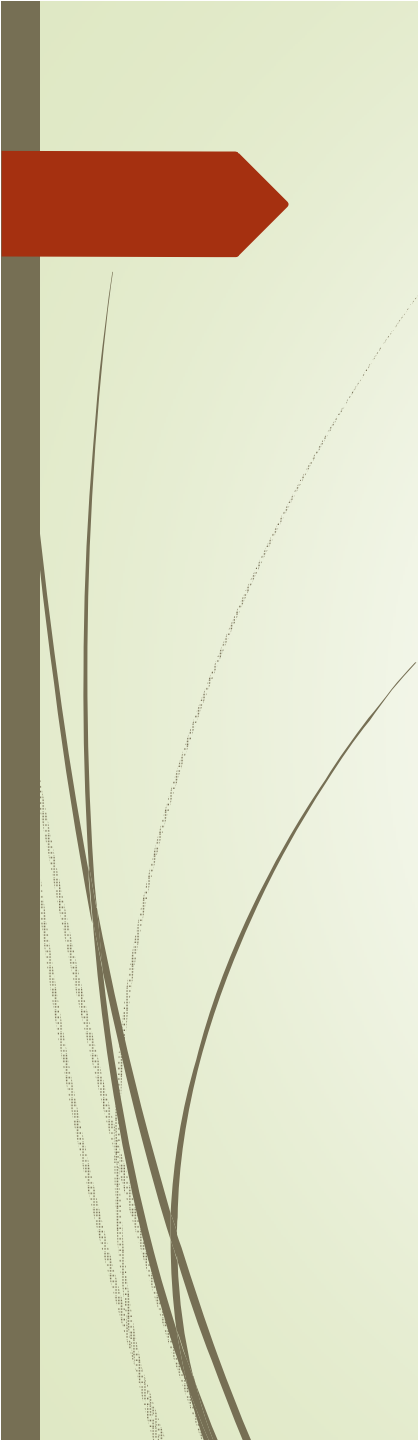


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- ▶ Also it was found that irradiation of a water solution of NaCl [ 5 ] and KCl [6] had a large influence on two-step processes of crystallization.
  - ▶ The irradiation of the solution produces metastable radicals of water and excited seeds which stimulate obtained a very fast, about 100 times, supercrystallization [5], [6] and repair the damaged molecules or ions by irradiated vacancies [1], [2].

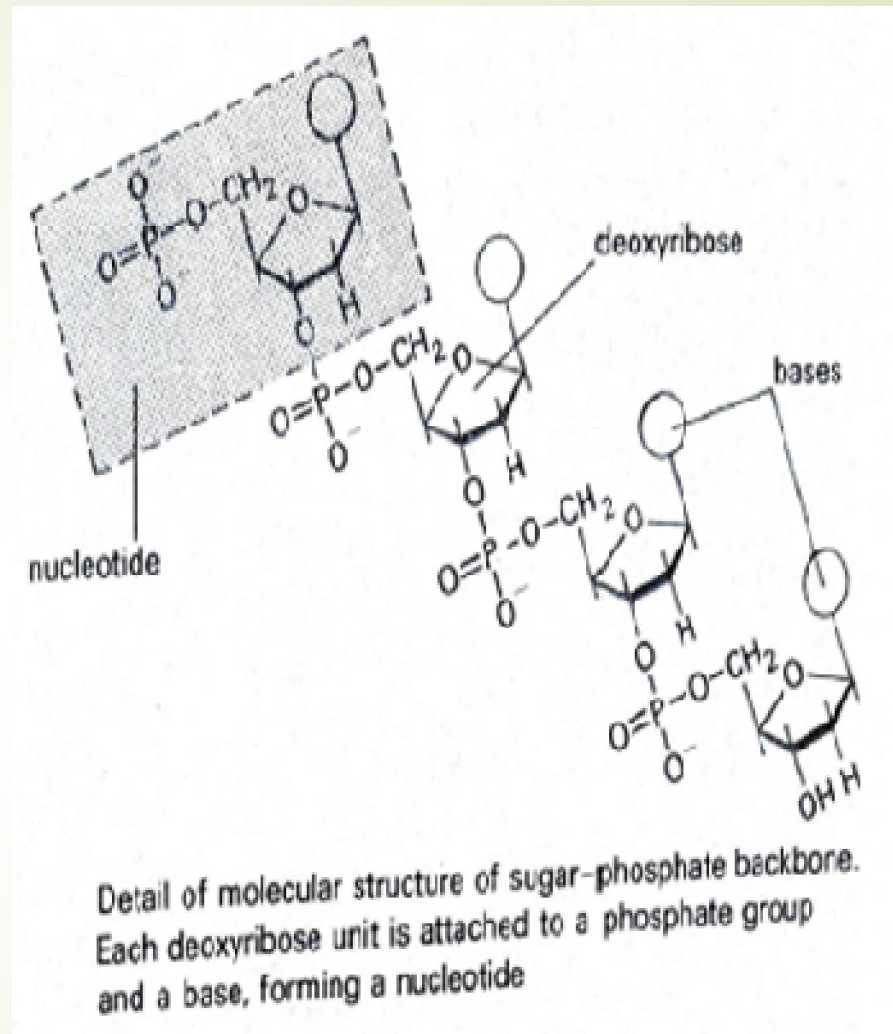


## 2. Cancer therapy method using soft X-rays

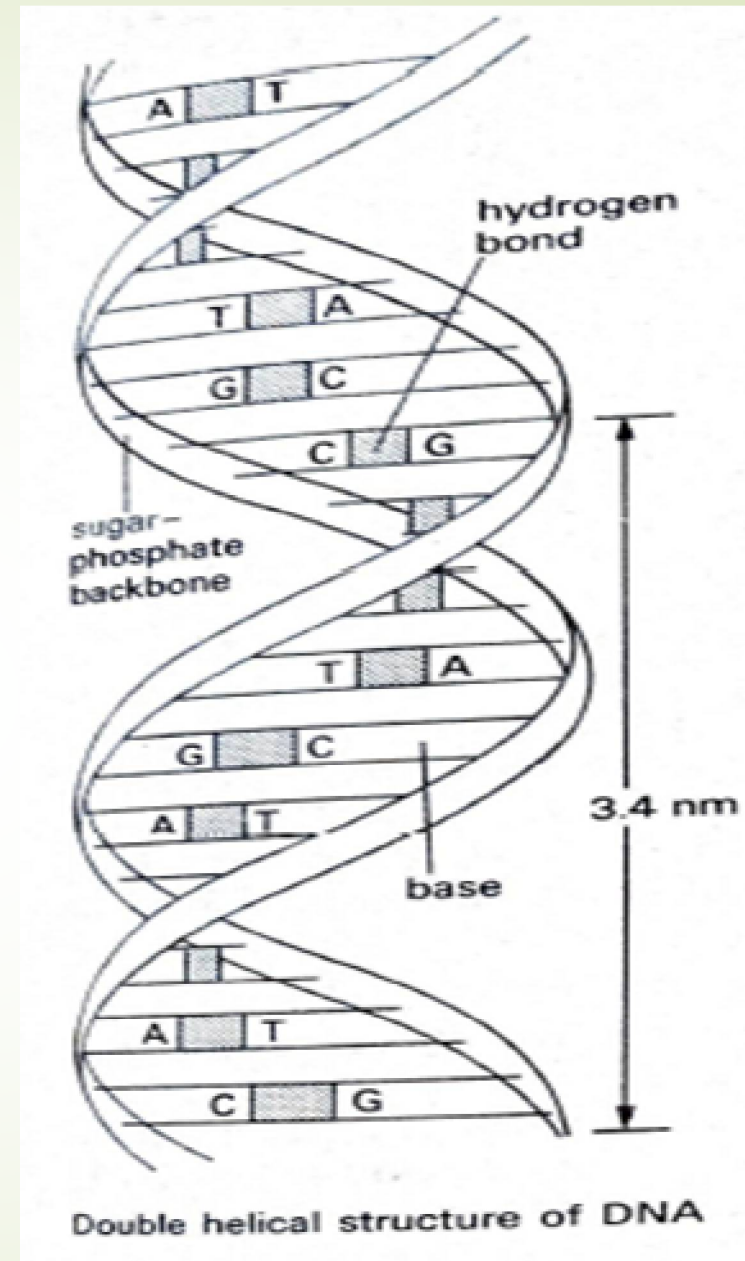
- ▶ We can suppose that Auger effect can be used for modification of genetic material defined by DNA taking part in protein synthesis structure.
- ▶ It is perspective to use of X-rays for irradiation with photons with energies greater [4] than 2148 eV, energy of electrons in K shell of phosphorus, in group phosphate nucleotides [7] (Fig.1) for elimination of phosphorus atoms and production of free oxygen atoms producing disintegration of double helical structure of fast dividing [7] DNA by cancer acting.

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- ▶ Also we can harm fast dividing chains of DNA with the electrons produced by Auger effect [4] of phosphorus atoms excited by soft X-rays of energy [4] 11keV. In this case can be avoided expensive irradiation with protons and ions using cyclotrons.
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  - ▶ In this case can be avoided expensive irradiation with protons and ions using cyclotrons.

# Structure of sugar-phosphate backbone



# Structure of DNA





## REFERENCES

- [1] Janavičius A. J., Banys J., Purlys R. , and S. Balakauskas, Lithuanian Journal of Physics, 42, No. 5, (2002) 337.
- [2] Janavičius A.J., Norgėla Ž., and Purlys R. , Eur. Phys. J. Appl. Phys. 29, (2005) 127.
- [3] Janavičius A. J., et all., PCT publication number WO/2014/062045, PCT declaration number PCT/ LT2013/000017, Declaration in USA No. 4/436,934
- [4] Janavičius A. J., S. Balakauskas, V. Kazlauskienė, A. Mekys, R. Purlys and Storasta J., Acta Phys. Pol. A., 114, (2008) 779.
- [5] Janavičius A. J., Purlys R. and Rinkūnas R., Acta Phys. Pol. A. 123, (2013) 777.
- [6] Janavičius A. J., Rinkūnas R. and Purlys R., epl, A Letters journal exploring the frontiers of physics, 116 (2016) 27001-p1.
- [7] Science Dictionary, Oxford University Press, Oxford, New York, 1991, p. 758.
- [8] Wang CG, US Patent 8, 278, 315, Radio therapy Method using X-rays, 2012.