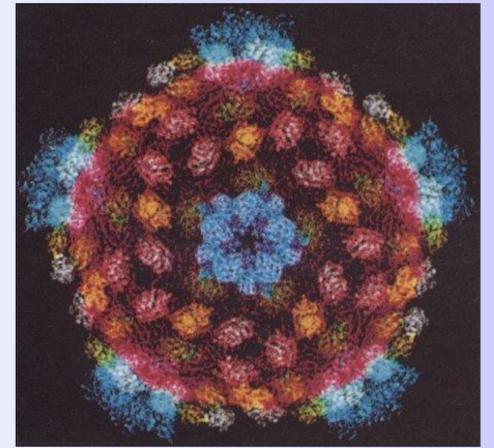


A super poison



K. M. Renisch, M.L. Nibert, S. C. Harrison, Nature, Vol. 404 (2000) 960

Structure of the reovirus core at 3.6 Å resolution

1. Two super poisons exist in nature. The first is, botulism, the second is tetanus: both of them kill in microgram amounts, by paralyzing the nervous system - tetanus by contractions, botulism by the atony.

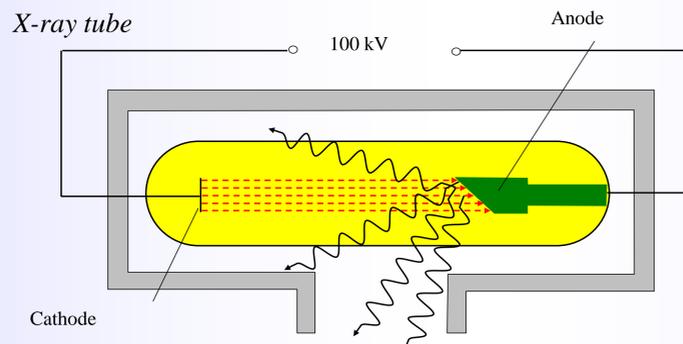
What do they have in common? A zinc atom along the protein chain, surrounded by four aminoacids.

How do we know this? From X-rays. ... continues



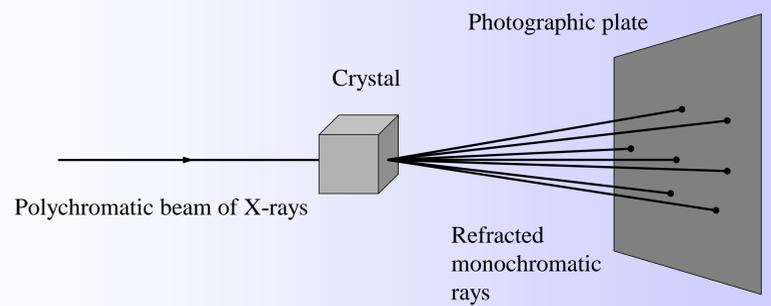
First X-ray medical apparatus
Deutsche Museum, München

First tube for X-rays
Science Museum, London



A penetrating electromagnetic radiation (X-radiation) is generated by slowing-down electrons or heavy charged particles. In an x-ray tube, electrons are accelerated by means of a high direct voltage to bombard a metal electrode. We call this slowing down a "bremsstrahlung".

Wilhelm Conrad Röntgen discovered X-rays by the case, on 25.11.1895. Then, he spent 5 weeks closed in the lab to study their nature. He received the first Nobel Prize in Physics, in 1901.



Diffraction of X-rays in monocrystal (configuration of von Laue)

Röntgen tried to verify the nature of the new rays: are they charged particles, like cathode rays (i.e. electrons) or electromagnetic waves, like the visible light.

He notices that X-rays propagate on straight lines and are not affected by electric or magnetic fields, so they could be electromagnetic waves but are not subject to refraction, interference or polarization. So for him, these were really "X-rays".

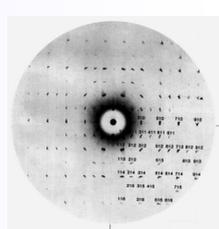
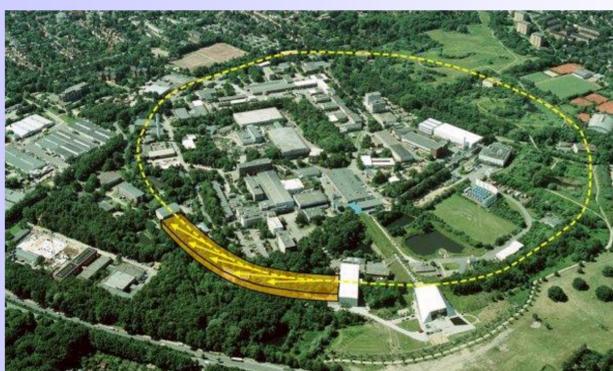
Now, we know, that X-rays are EM waves, but ultrashort (in the Å range), so an appropriate diffraction grid must have the same order of spacing. A crystal of atoms would do it!

Atoms, regularly positioned in crystals, form a diffraction grating for X-rays. Specific patterns on the screen allow to determine the symmetry and reticular constants of the crystal.

Synchrotron - a modern source of X-rays (DESY, Hamburg)

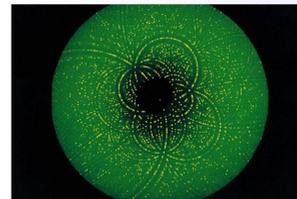
How does DNA look like?

Röntgen's rays in biology - structure of a protein



Encyklopedia Fizyki Współczesnej, PWN, Warszawa, 1983

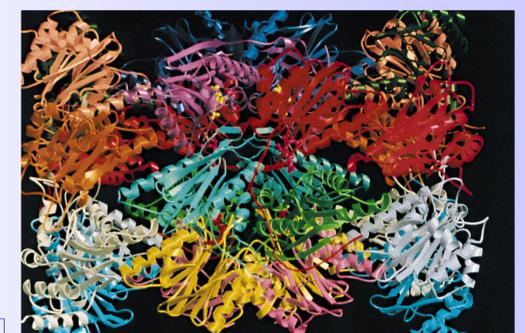
X-ray diffractogram of DNA (its Na salt) and of a complex protein



DESY, Hamburg

The shape of DNA was not discovered by any super-biological microscope but by Physics methods.

J.D. Watson and F.H.C. Crick in 1958 observing quite a complicated X-ray interferograms of the DNA crystals, wondered if it were a single or a double spiral. Finally, their choice was correct what awarded them with a Nobel prize in 1962.



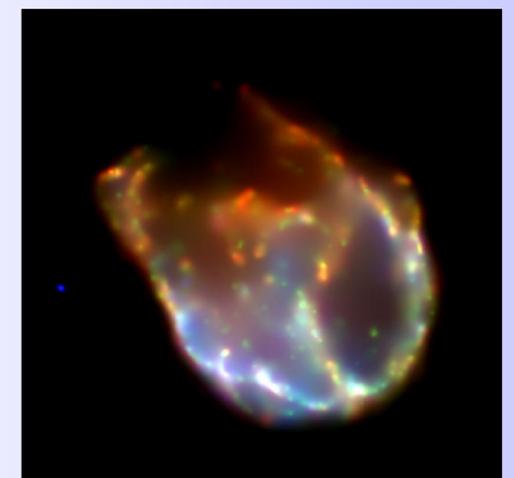
Credits: DESY, Hamburg
<http://www.desy.de/pr-info/desyhome/html/presse/fotos/hasylab/index.en.html>

The X-radiation produced in cyclotrons possesses many properties which simply cannot be achieved using conventional sources such as X-ray tubes. Here, the beam of electron traveling with velocities close to the velocity of light, produces an intense and well collimated radiation, every time the beam is deviated from a straight-line trajectory (like the radio-waves from ionized matter circulating a black hole in quasars).

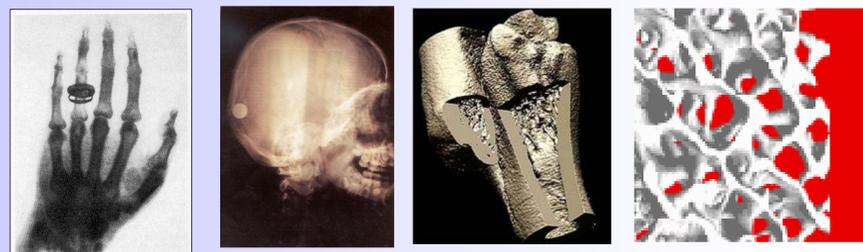
This "true colour" image of N132D from NASA's Chandra X-ray observatory shows the beautiful, complex remnant of an explosion of a massive star in the Large Magellan Cloud, a nearby galaxy about 180.000 light years from Earth. The colours represent different ranges of X-rays with red, green, and blue representing, low, medium, and higher X-ray energies respectively.

http://imagine.gsfc.nasa.gov/docs/features/exhibit/xray_anniversary3.html

Röntgen's rays in astronomy



X-rays in medicine: from the wedding ring of Röntgen's wife, to a micro structure of bones



<http://www.microphotonics.com/> <http://www.adelaide.edu.au/microscopy/>

2. How does such a poison work? It attacks a very specific protein of the cellular membrane of the neurons, which is responsible for the transmission of electrical signals, cutting this protein into two parts. In this way, nervous signals are interrupted – a sure death, even at a minimal dose!

continues...

3. What is dangerous in this story is that the Mother Nature, in her all wickedness invented only two such super poisons. How many combinations of super poisons can be creates with 16 aminoacids in three substitutions around the Zn atom? How many of them have been already done by Man? Fine