A radionuclide (radioactive nuclide,radioisotope or radioactive isotope) is an atom that has excess nuclear energy. making it unstable.This excess energy can either create and emit(发射),from the nucleus（原子核中）,new radiation(gamma radiation) or a new particle (alpha particle or beta particle),or transfer this excess energy to one of its electrons, **causing it to be ejected (conversion electron)**.**During this process,the radionuclide is said to undergo radioactive decay(在这个过程中放射性核元素发生了进一步的衰变).**These emissions constitute ionizing radiation(电离辐射).The unstable nucleus is more stable **following the emission**(在发射之后),bu will sometimes undergo further decay(但是有时候会经历更进一步的衰变).**Radioactive decay(放射性的衰变)** is a random process at the level of single atoms:it is impossible to predict when one particular atom will decay.However,for a collection of atoms of a single element(对于一个单一的元素集合) the decay rate,and thus the half-life (t1/2) for that collection can be calculated from their **measured decay constants(测量的衰变常数)**. The duration of the half-lives of radioactive atoms have no known limits(放射元素的半衰期没有已知的限制);the time range is over 55 orders of magnitude.

Radionuclides both occur naturally and are artificially made using nuclear reactors,cyclotrons,particle accelerators or radionuclide generators.There are about 650 radionuclides with half-lives longer than 60 minutes (see list of nuclides).（大概有650种）Of these,34 are primordial radionuclides that existed before the creation of the solar system(有34种在太阳系诞生前就存在的原始放射性的核素),and there are another 50 radionuclides detectable in nature as daughters of these,or produced naturally on Earth by cosmic radiation.More than 2400 radionuclides have half-lives less than 60 minutes.Most of these are only produced artificially,and have very short half-lives.For comparison,t**here are about 254 stable nuclides.**

All chemical elements have radionuclides.Even the lightest element,**hydrogen**,has a well-known radionuclide, tritium**(氚)**.Elements heavier than lead(铅),and the elements technetium锝 and promethium钷,exist only as radionuclides. Unplanned**（意外的）** exposure to radionuclides generally has aharmful effect on living organisms including humans,although low levels of exposure occur naturally without harm.The degree of harm will depend on the nature and extent of the radiation produced,the amount and nature of exposure (close contact, inhalation or ingestion)（密切的接触，吸入或者摄取）,and the biochemical properties of the element;with increased risk of cancer the most usual consequence.However, radionuclides with suitable properties(具有适当的性质的) are used in nuclear medicine for both diagnosis and treatment.An imaging tracer made with radionuclides is called a radioactive tracer.A pharmaceutical**(治病的药物)** drug made with radionuclides is called a radiopharmaceutical.

**第二张ppt**

**α-particles（ alpha rays or alpha radiation）** are found to be helium nuclei with two protons and two neutrons, flying out at high speed.(被发现是具有两个质子和两个中子的氦核，以高速飞出。)

**β-particles** are electrons that are ejected from a nucleus. (从原子核中射出的电子)

Normally, nuclei have high energy and are therefore still unstable immediately after emission of α-particles or β-particles, so they will further emit γ-rays in order to become stable. However, some do not emit γ-rays.（通常情况下，原子具有很高的能量，因此在发射出α粒子或β粒子后仍然不稳定，所以它们会进一步发射出γ射线，以便变得稳定。然而，有些则不发射γ射线。）

While α-particles, β-particles, and γ-rays are emitted from a nucleus, X-rays are electromagnetic waves that are generated outside a nucleus. Unlike X-rays, γ-rays are generated from a nucleus, but both are electromagnetic waves.( α粒子、β粒子和γ射线是从原子核中发射出来的，而X射线是在原子核外产生的电磁波。与X射线不同，γ射线是从原子核中产生的，但两者都是电磁波。)

**A neutron** is a particle that constitutes a nucleus. Neutrons that are ejected from a nucleus with kinetic energy, e.g. during the fission of the nucleus, are called neutron beams.（中子是构成原子核的一种粒子。从原子核中喷出的具有动能的中子，例如在原子核裂变过程中，被称为中子束）

**第三张ppt**

Radiation generally means ionizing radiation. Ionizing radiation, which has the ability to ionize atoms that make up a substance (separate the atoms into positively charged ions and negatively charged electrons), is categorized into particle beams and electromagnetic waves.( 辐射一般指电离辐射。电离辐射具有使构成物质的原子电离的能力（将原子分离成带正电的离子和带负电的电子），可分为粒子束和电磁波。)

Particle beams include α (alpha)-particles, β (beta)-particles, neutron beams, etc.

Particle beams include charged (ionized) particle beams and uncharged particle beams. γ (gamma)-rays and X-rays are types of electromagnetic waves.( 粒子束包括α（α）粒子、β（β）粒子、中子束等。粒子束包括带电（电离）粒子束和不带电粒子束。γ（伽马）射线和X射线是电磁波的类型。)

Some forms of electromagnetic waves, such as electric waves, infrared rays, and visible rays, do not cause ionization, and they are called nonionizing radiation. Ultraviolet rays are generally categorized as nonionizing radiation although some ultraviolet rays do cause ionization (一些形式的电磁波，如电波、红外线和可见光，不会引起电离，它们被称为非电离辐射。紫外线通常被归类为非电离辐射，尽管一些紫外线确实会引起电离。)

最后一张ppt

The source of radioactivity is an atom so obese that it defies the laws of attraction gluing together our material world and spits out little pieces of itself -- two kinds of particles and a stream of gamma rays, similar to X-rays. An overdose of gamma rays is like a vicious sunburn, with skin damage and elevated cancer risks, but those particles are too big to penetrate our skin, meaning that they need to be swallowed or inhaled to wreak damage. The truly fearful event in a nuclear accident, then, isn't fallout but meltdown, where the core burns through the floor and suffuses the water table. There it causes agricultural havoc and radioactive dust that you better not breathe. We're not dropping dead all together from radiation poisoning or its ensuing cancers on a daily basis because, like all poisons, it isn't the particular atom that will get you. It's the dose. And damage from radioactivity requires a much greater dose than any of us would have believed.（放射性的来源是一个肥胖的原子，它违背了将我们的物质世界粘在一起的吸引力法则，并吐出自己的小碎片--两种粒子和一股伽马射线，类似于X射线。过量的伽马射线就像恶性晒伤一样，会造成皮肤损伤和癌症风险升高，但这些粒子太大，无法穿透我们的皮肤，这意味着它们需要被吞咽或吸入来造成损害。那么，核事故中真正可怕的事件不是落尘，而是熔毁，即核芯烧穿地板，充斥着水层。在那里，它会造成农业灾难和放射性灰尘，你最好不要呼吸。我们不是每天都会因辐射中毒或随之而来的癌症而死亡，因为像所有的毒药一样，不是特定的原子会让你死亡。而是剂量的问题。而放射性的损害需要比我们任何人都相信的更大的剂量。）