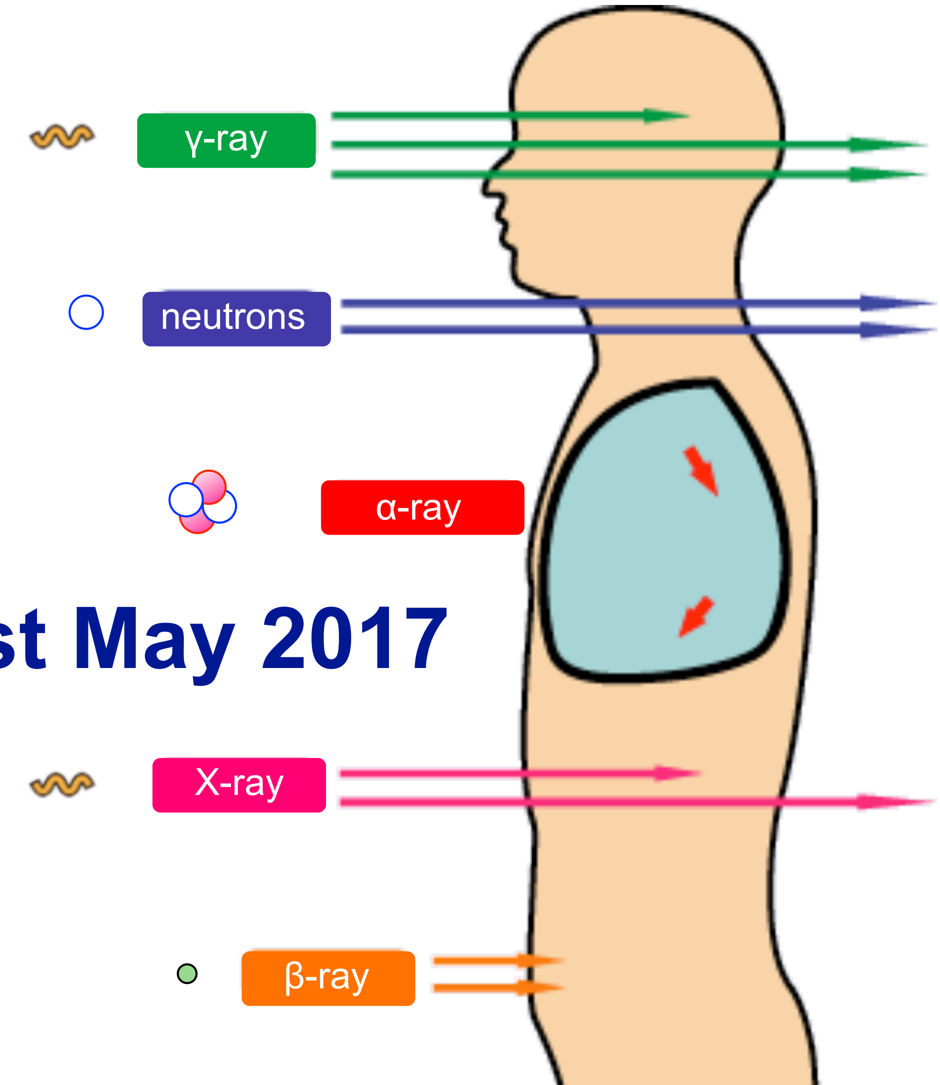
Lecture for 3rd-year students, Chemistry dept.



Wed. 31st May 2017

6th lecture Interaction between radiation & matter (II)

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Exam : on Wed. 28th June 2017

Don't forget to bring your

scientific calculator.

Use of portable phones or smart phones are not allowed.

Problems will be printed both in Japanese & English

Answers will be accepted in either of the two languages.

試験日：2017年 6月28日（水）

関数電卓を持参すること。

携帯電話やスマートフォンの

使用は許可しない。

出題は英日併記。解答は英日いずれも可。

PET (Positron Emission Tomography)

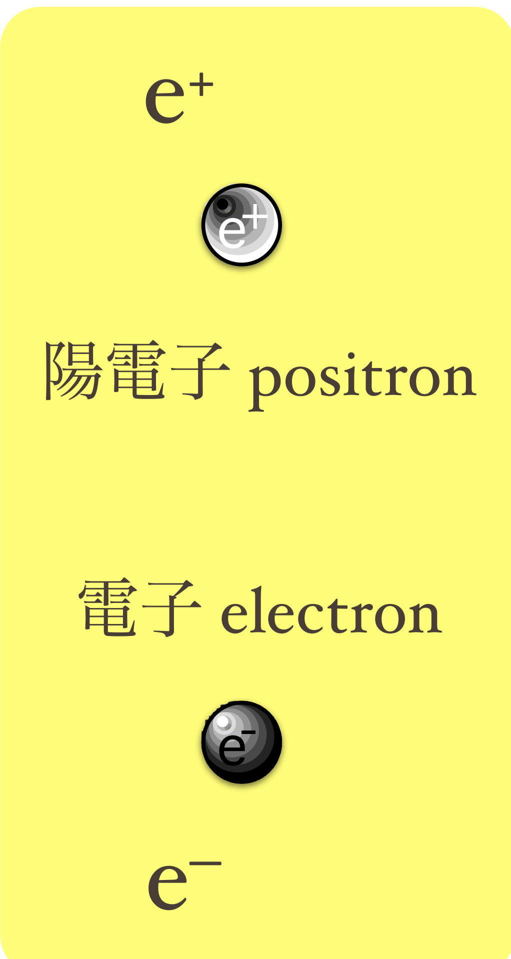
陽電子断層撮影法

組織の"はたらき"を知る

Probing the function of tissues.

^{18}F-FDG (fluorodeoxy glucose), $^{15}O_2$, $H_2{}^{15}O$

$e^+ + e^- \rightarrow \gamma + \gamma$ (511 keV)



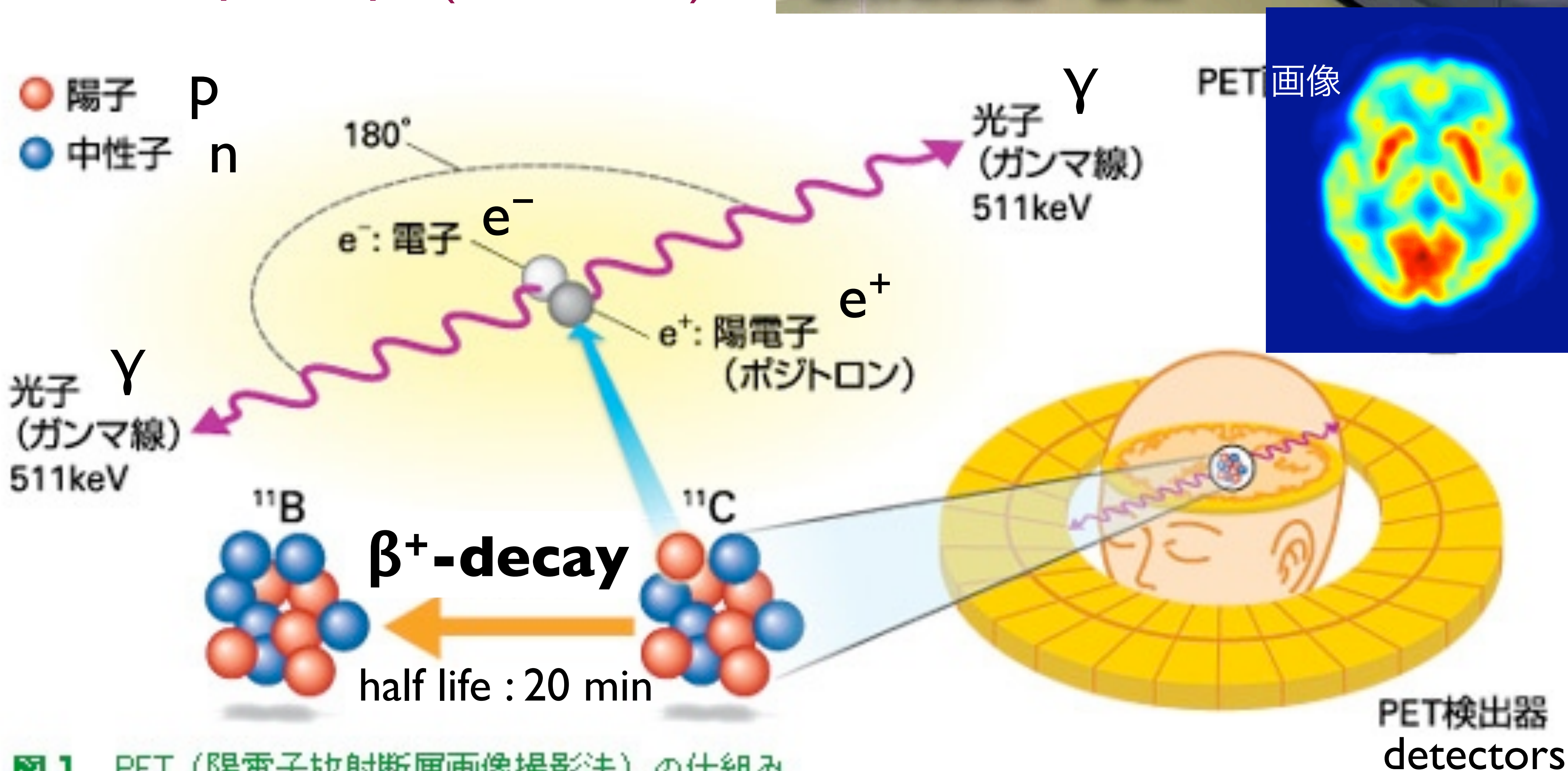
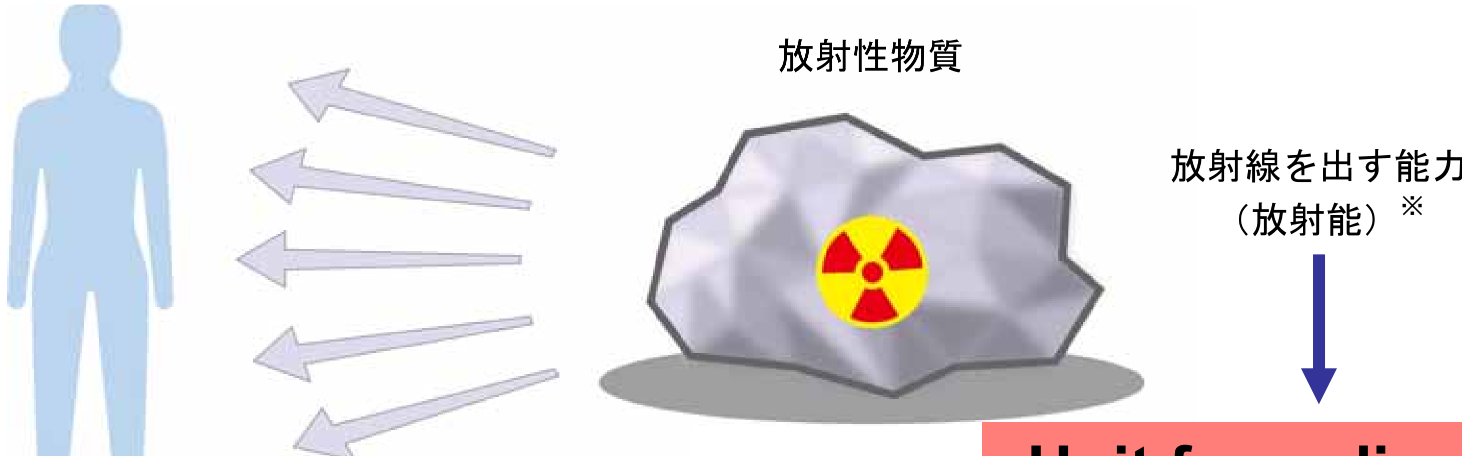


図1 PET（陽電子放射断層画像撮影法）の仕組み

調べたい分子に陽電子を放出する放射性核種を付け、静脈注射によって投与する。例えば、炭素 11（¹¹C）はホウ素 11（¹¹B）に崩壊するとき、陽電子を 1 個放出する。その陽電子が近くにある電子と衝突し、両方向にガンマ線が放出される。検出器がガンマ線をとらえることで断層画像が得られ、分子がどこに、どれだけ存在しているのかを知ることができる。

^{11}C, ^{13}N, ^{15}O, ^{18}F

Units of radiation



Unit of radiation intensity and its effect
Sievert [Sv]

Unit for radioactivity
Becquerel [Bq]

Units of radiation

Absorbed dose 吸収線量 D [J / kg] = [Gy] (gray)

Equivalent dose 等価線量 H_T [J / kg] = [Sv] (sievert)

Effective dose 実効線量 E [J / kg] = [Sv] (sievert)

Unit of radioactivity

Radioactivity (becquerel)

[dps] = [s^{-1}] = [Bq]

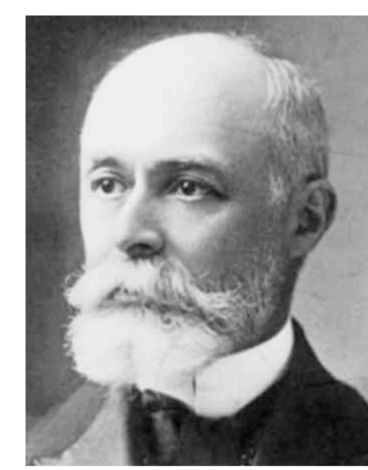
decay / disintegration per second

1 Ci = 37 GBq

Gray 

 Sievert


Curie


Becquerel

Units of radiation

In the radiation field, there exist
various types of radiation (photons & particles)
with different energies
flying into diverse directions
at respective intensities.

This complicated situation can never be expressed with a single physical quantity.

Many different sorts of units are defined.

Units of radiation dose

Röntgen

Gray

radiometric quantities 放射計測量

particle fluence Φ [cm^{-2}]

energy fluence Ψ [$MeV\ cm^{-2}$]

dosimetric quantities 線量計測量 : energy conversion

kerma カーマ (Kinetic Energy Released in MAterial / MAtter) **NOT for charged particles** K [J / kg] = [Gy]

cema シーマ (Charged particle Energy imparted to MAtter) **for charged particles** C [J / kg] = [Gy]

照射線量
exposure dose **photons (X/γ-ray)** X [C/kg], [R] röntgen 1 R ≈ 2.58×10^{-4} C/kg

dosimetric quantities 線量計測量 : energy deposition

absorbed dose D [J / kg] = [Gy], [erg / g] = [ram] 1 Gy = 100 ram

吸収線量 gray

radiation doses

- Energy absorbed by matter (per unit mass)

Absorbed dose D [J / kg] = [Gy] **gray**
吸収線量

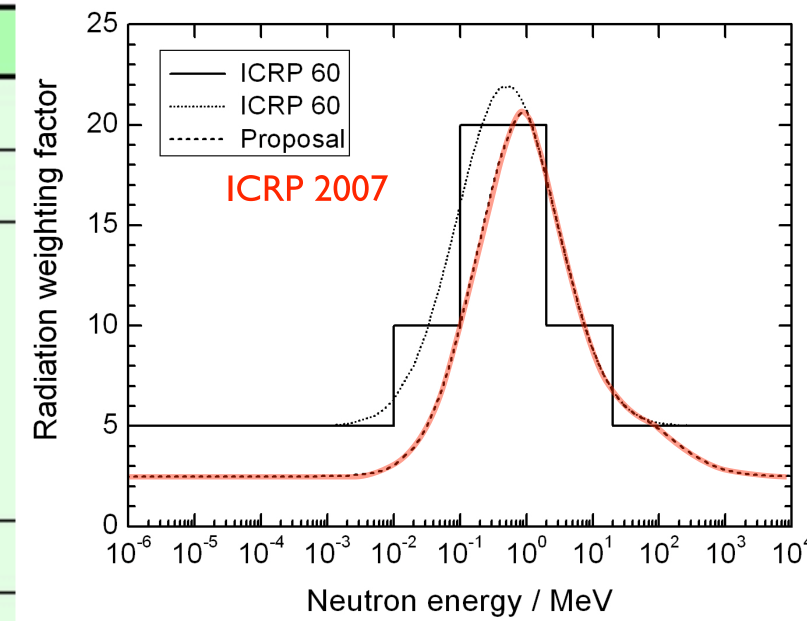
Gray

- Biological effectiveness considered (for different types of radiation).

等価 線量
Equivalent dose $H_T = w_R \times D$ [Sv] **sievert**

Radiation weighting factor w_R

Type of radiation & energy region	Radiation weighting factor w_R	
photons (X/γ-ray) ; all energies	1	1
electrons (β-ray) and muons ; all energies	1	1
neutrons ; < 10 keV 10keV～100keV 100keV～2MeV 2MeV～20 MeV 20MeV +	5 10 20 10 5	see right figure
protons except for recoil protons ; > 2 MeV	5	2 (also for pions)
alpha particles (α-ray)	20	20
fission fragments	20	20
heavy nuclei	20	20



［出典］ 日本アイソトープ協会:ICRP Pub 60、国際放射線防護委員会の1990年勧告、丸善、p7(1991)

red : ICRP 2007

- Effect calculated and converted for full-body exposure.
(Summed over tissues with **tissue weighting factor** w_T)

Effective dose $E = \sum_T w_T \times H_T$ [Sv] **sievert**
実効線量

Sievert

Fine. Per oggi è tutto.

Fini pour aujourd'hui

That’s all for today.

Всё за сегодня.

오늘은 이만 마치겠습니다.

今天就学到这儿了。

Ci vediamo la prossima settimana.

On se voit la semaine prochaine.

See you next week.

Увидимся на следующей неделе.

다음 주에 또 만납시다.

下周见。