Introduction
(Tuesday 9-11)

Presentation & a small history lesson

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KJM 5900 - Learning goals

- Understand what radioactivity is and why it's emitted.
- Basic understanding of the atomic nucleus.
- Be able to work safely with radioactive material.
- Be able to measure radioactivity.
- Be familar with the most common uses of radioactivity.
- Be familar with laws and regulations concerning radiation.
- Be able to evaluate the risks involved in radioactive work and arrising from accidents.

Practical information (I)

Uke:	Tema:		Oppgave:	Kommentar
34	Nuklider og radioaktivitet (I) Strålevern og arbeidsrutiner på labben	4t (PH) 6t (JPO)	Laboppgave A, B og C Regneoppgaver og gruppeoppgave	Intensivuke i Oslo (se egen plan)
35				Les og repeter forrige ukes pensum!
36	Nuklider og radioaktivitet (II)	2t (PH)	Oppgave 1: Regneoppgavesett	
37	Deteksjon og spektroskopi	2t (PH)	Oppgave 2: Nal detektoren - grunnleggende bruk av en radioaktivitetsdetektor	**Mappe innlevering**
38	Naturlig forekommende radionuklider	1t (PH)	Oppgave 3: Måling av γ-stråling med Ge-detektor, bestemmelse av ukjent prøve	Obligatorisk
39	Kjerneparametre og -modeller	1t (PH)	Oppgave 4: Regneoppgavesett	
40	Kjernereaksjoner	2t (PH)	Oppgave 5: RoboLab - n-aktivering	**Mappe innlevering**
41	Fisjon og kjernereaktorer	2t (PH)	Oppgave 6: Regneoppgavesett	
42	Produksjon av radionuklider	2t (PH)	Oppgave 7: RoboLab - Absorpsjon av γ-stråling	Obligatorisk
43	Praktiske anvendelser	2t (PH)	Oppgave 8: Regneoppgavesett	
44	Analysemetoder	2t (PH)	Oppgave 9: Måling av Radon ved hjelp av et aktivt luftfilter	Obligatorisk
45			Oppgave 10: Regneoppgavesett	**Mappe innlevering**
46/47/48	Selvstudium			
49/50	Eksamen			

Practical information (II)

	Mandag	Tirsdag	Onsdag	Torsdag	Fredag	Lørdag
08-09	KJM 1050		Radioaktiv stråling (PH)	Strålevern (JPO)	Strålevern (JPO)	
09-10		Innledning (JPO)				Labintro (JPO)
10-11	KJM 4020		Oppgavelesning	Robolab intro.	Oppgavelesning	Oppgave C (LAB)
11-12		(lunsj)	Labintro (JPO)	Labintro (JPO)	Robolab avslse	
12-13	(Lunsj)	Atomkjerner og radioaktivitet (PH)	KJM 4020	(lunsj)	KJM 4020	(lunsj)
14-15			KJM 4020		KJM 4020	Oppgave C forts.
14-15		Oppgavelesning & Pensumlesing	Oppgave A (LAB)	Oppgave B (LAB)	Gruppeoppgave	Oppsummering
15-16						
16-17						
17-18						
18-19						

What *is* radioactivity?

- Discuss with your neighbour!

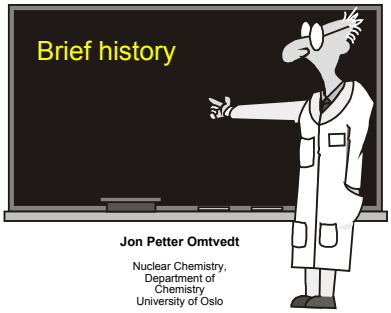
Why is radiation dangerous?

- **Chemical binding energies are of the order of eV (electron Volt).**
- **Radioactive radiation usually has energies in the keV and MeV ranges (i.e. 100 too more than one million times as much as a chemical bound).**
- **If such amount of energy is deposited in matter (e.g. a part of the body), a large amount of chemical bounds will be broken.**

Pregnant?

If you are pregnant please inform one of the teachers before attending the laboratory course.

Brief history



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The famous history

- Radioactive radiation from uranium was discovered in 1896 by Becquerel.
- In 1898 Schmidt and M. Curie discovered similar radiation from thorium.
- Marie and Pierre Curie soon discovered the new elements Po and Ra, which was intensivly radioactive.
- In 1899 Ernst Rutherford started to study the nature of the radioation and discovered that it consisted of three main types: α-, β-, and γ-radiation.
- Soon this exiting new research field exploded and lead to our current understanding of the atomic nucleus and the processes which are responsible for the radiation.

Professor Ellen Gleditsch (1879-1968)

- The young pharmacist Ellen Gleditsch was employed as assistant to prof. E. Bødtker in 1903.
- She soon showed her scientific qualities and was able to take her "PhD" in 1906, after much hard work.
- She then worked as associate professor until 1907.
- The exciting developments in the Curies laboratory draw her to Paris.
- The french laboratories was crowded, but Bødtker was able to convince M. Curie that his assistant was worthy and that she "was so small she would hardly occupy any laboratory space". Beside this, Curie needed a chemist.

Ellen Gleditsch, Student 1902

Gleditsch, early years

- Gleditsch came to Paris late in 1907, where she initiated a lifelong, personal friendship with M. Curie.
- In Paris Gleditsch proved her worth and made significant scientific contributions. She stayed for five years, until 1912.
- She was now the definitive authority on radioactivity in Norway.
- In order to continue her research, she went to Prof. Boltwood at Yale University in 1913 to 1914 (the equipment in Oslo was grossly inadequate).

Gleditsch in 1929

The fundation of Nuclear Chemistry in Oslo

- When she came back to Norway, Gleditsch was employed in a new position in radiochemistry at the University of Oslo in 1916.
- She created and lead an active group of researchers in nuclear chemistry, and lay the foundations for all future nuclear chemistry work in Norway.
- In 1929 she was appointed to the proffesorship left after Goldschmidt. Thus, she also became the leader of the section for Inorganic Chemistry. She was the second female professor in Norway.
- She formaly retired in 1946, but was active many years after that - she gave her last talk in 1967, at an age of 88 years!

Gleditsch gets a honorary doctorate at La Sorbonne in 1962.

Nuclear Reactors and IfA

- After WWII much of the Norwegian infrastructure needed to be rebuilt. This was specially true for science and technology - the corner stones of the modern society Norway wished to become.
- In 1945 a committee led by the astro-physicist Gunnar Randers was established to investigate the possibilities given by nuclear reactors.
- In 1947 funding was approved by the government and the *Institute for Atomic Energy* (IfA) was created.
- However, to construct the reactor exceptional talent and practical skill was needed.
- Fortunately, Norway had such a man: *Odd Dahl*.

Randers and Einstein

Odd Dahl

- Born in 1899, Odd Dahl became one of Norway's most admired scientists.
- He did not have any "classical" education as a scientist, but was mostly self educated.
- In 1922-25 he participated in Roald Amundsen's exploration of the arctic. He enrolled as a pilot, but soon showed his talents in a variety of other fields. In his spare time aboard Maud he read physics.
- After the Maud-expedition he worked at the Carnegie Institute of Technology in Washington. He stayed in the US for 10 years and came back to Norway as a distinguished and well-known scientist.
- In Norway, he worked at the Christian Michelsen Institute (CMI) in Bergen. Under the influence of Dahl the main activity at CMI became science and technology.

JEEP I

From the start-up of JEEP I in 1951

- Thanks to the exceptional engineering and scientific abilities of Dahl, Randrups dream became true: The JEEP I nuclear-research reactor went critical on the first try in 1951.
- Norway was the sixth country which built a nuclear reactor (after USA, UK, USSR, France and Canada).
- Many obstacles had to be overcome in order to get uranium for the reactor (many of them was created by the US), finally Norway got uranium from the Netherlands.

Alexis C. Pappas

- When Gleditsch gradually stepped down her teaching at the University of Oslo, one of her brightest pupils took her place: Alexis C. Pappas.

- Pappas was employed as scientific assisent to Gleditsch between 1941-47.
- He worked in Paris in 1948 and 49.
- After that, he returned to the University of Oslo.
- He worked at the Massachusetts Institute of Technology in Boston between 1949 and 51.
- Pappas was given a professorship in radiochemistry from the National Cancer Society in 1957.
- In 1962 he was employed by the University as professor in nuclear chemistry.

Pappas' work

- Pappas nuclear chemistry group in Oslo was highly regarded and educated a huge number of both Norwegian and foreign students. At the most intense, more than 30 students were working in Oslo.
- Pappas played a major part in the international collaboration to build CERN in Geneva.
- He and prof. Rudstam (Uppsala University) were the main forces behind the then unique ISOLDE project at CERN for studying nuclei far from stability.

Picture from the celebration of Pappas' 60 years birthday.

The "glory" of nuclear energy fades...

- The enthusiasm about nuclear energy faded in the 70's.
- For a land generously provided with ample amounts of hydro power, it was easy for the politicians to abandon nuclear energy to please the voters.
- At the same time oil was discovered below the sea outside the Norwegian coast and the politicians decided that "Norway will not use nuclear energy in the foreseeable future".

IfE - the Institute for Energy research

- ➜As it became evident that Norway would not exploit nuclear energy, IfA went trough a major reform to survive.
- ➜In 1980 it changed name to "the Institute for Energy research" (IfE) and started to employ its considerable engineering and scientific expertise to participate in developing installations in the North Sea.
- ➜Today IfE has major national and international projects for the petroleum industry. Many projects uses nuclear methods, e.g. tracers, to achieve it goals.
- ➜In addition, IfE continues its highly regarded international research on reactor technology and safety.

Nuclear Chemistry after Pappas

- ➜When Pappas retired in the middle of the 80's the University of Oslo had undergone major reforms. It had became "absolute democratic" and each researcher worked independently. All decisions were made by committees.
- ➜Furthermore, after the unions blocked a wage raise for the associate professors, everybody with professor "competence" are entitled to a "professorship". This was done in order to circumvent the union and give the scientists a wage rise.
- ➜Due to this, the research in Oslo has in many cases become fragmented - too many one-man groups have emerged. This was also true for the Section for Nuclear Chemistry (which was renamed the "Nuclear Chemistry Group" in the 1990s).
- ➜Today, the Nuclear Chemistry Group consist of prof. Per Hoff, and yours truly. In addition, prof. Tor Bjørnstad is working in the Nuclear Chemistry Group on a 20% basis (Prof. II).

The Future: Will Nuclear Physics and Chemistry become SAFE?

- ➜An initiative has been taken to merge the small nuclear physics and chemistry groups into a larger unit. (SAFE = "Senter for Akseleratorbasert Forskning og Energiteknikk" or "Centre for Accelerator Based Research and Energy Technology").
- ➜SAFE intend to become *the* Norwegian national facility for nuclear research.
- ➜It will be located in the West-wing of the Chemistry building (where the nuclear chemistry group is today) and the cyclotron at the Physics Insitute will be used as basis for most of the research.
- ➜Major research areas will be:
  - ✓ Medical related research (PET and cancer therapy with α-emitters).
  - ✓ Investigation of nuclear structure in highly exited nuclei without angular momentum.
  - ✓ Exploration of the chemical properties of the heaviest elements (Z>104).
  - ✓ Use of tracer technology in petroleum exploration and production.

Today's propaganda:

- SAFE offers many new possibilities for students!
- Many exiting student projects will be available within a large range of disciplines.
- An exciting and international student milieu.
- Opportunities for short and/or long term visits to the worlds biggest and most respected laboratories.

Sources

- T. Kronen and A.C. Pappas: "Ellen Gleditsh", Aventura 1887, ISBN 82-588-7145-5.
- Proceedings to Symposium "Aspects of Nuclear Science - In Honour of Prof. A. C. Pappas", Ed. E. Hagebø and B. Salbu, Norwegian University Press, 1985, ISBN 82-00-18343-2.
- F. Lied, J. Ofstad, T. Gjelsvik, J.C. Hauge: "En av Norges store sønner", Aftenposten 23. June, 1994.
- Prof. Jorolf Alstad - private communication 2001.
- Prof. Tor Bjørnstad - private communication 2001.
- Prof. Einar Hagebø - private communication 2001.