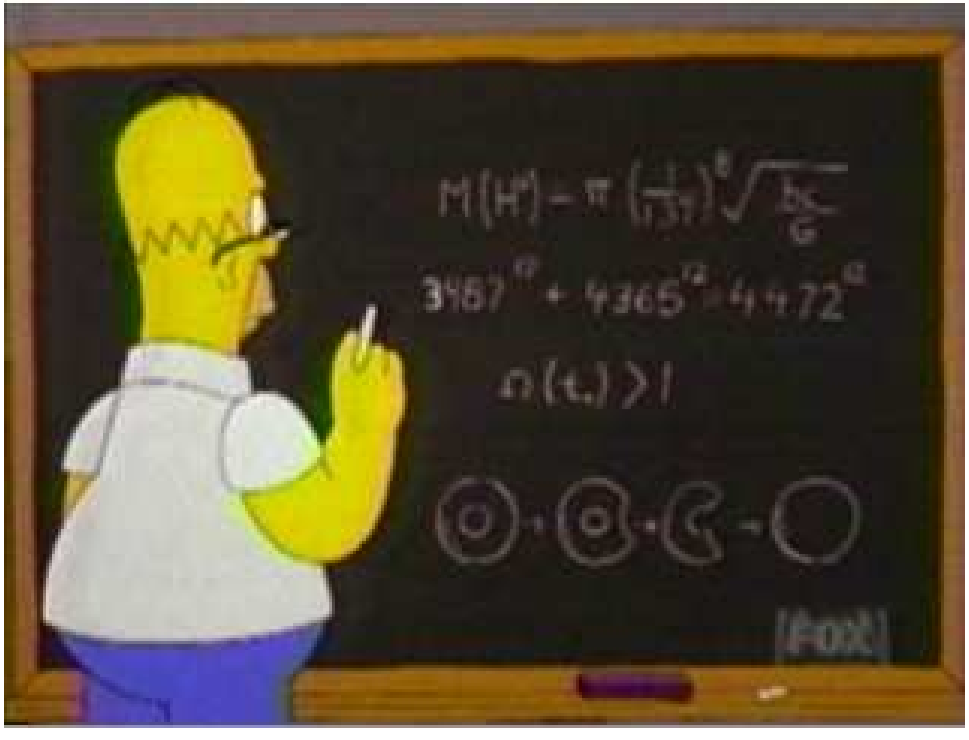
In Awe of Atoms:

The Lego Blocks of Stuff

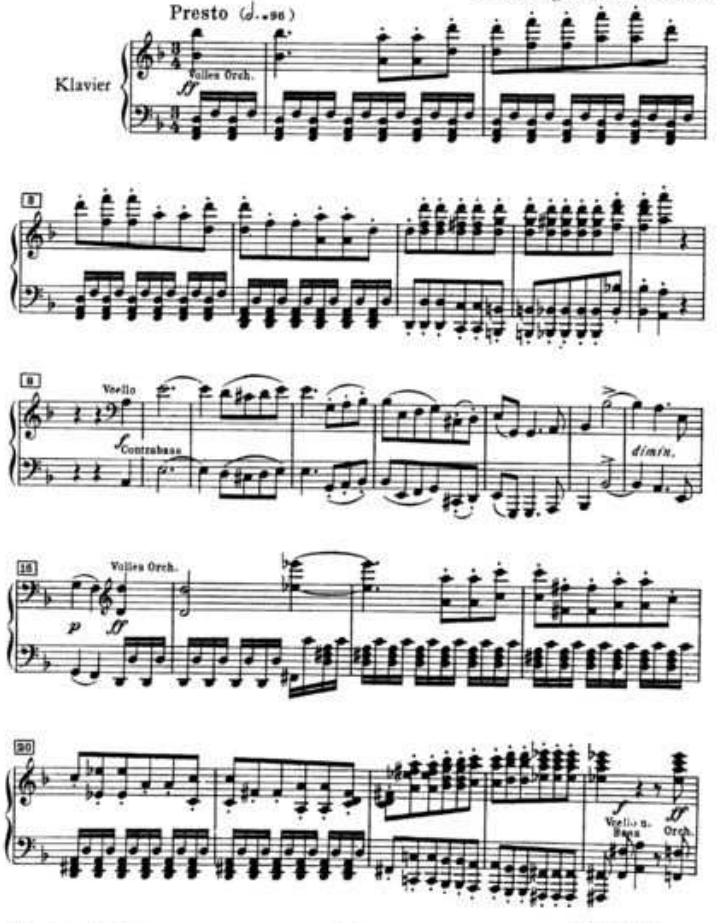


Letzter Satz

der Neunten Symphonie mit dem Schlusschor

über Schiller's Ode „An die Freude"

Ludwig van Beethoven (1770-1827)
Opus 125
Klavierauszug von Richard Hofmann



Theory of Everything *Else*

Langevin dynamics (Models A through J):

$$\begin{aligned}\frac{\partial \Psi_\mu(\vec{x},t)}{\partial t} &= \{F,\Psi_\mu(\vec{x},t)\}_{PB} - M_{\mu\nu}\frac{\partial F}{\partial \Psi_\nu} + \eta_\mu(\vec{x},t) \\ &= -\int \{\Psi_\mu(\vec{x},t),\Psi_\nu(\vec{x}',t')\}_{PB}\frac{\partial F}{\partial \Psi_\nu}d\vec{x}' - M_{\mu\nu}\frac{\partial F}{\partial \Psi_\nu} + \eta_\mu(\vec{x},t) \\ &= V_\mu(\vec{x},t) - M_{\mu\nu}\frac{\partial F}{\partial \Psi_\nu} + \eta_\mu(\vec{x},t)\end{aligned}$$

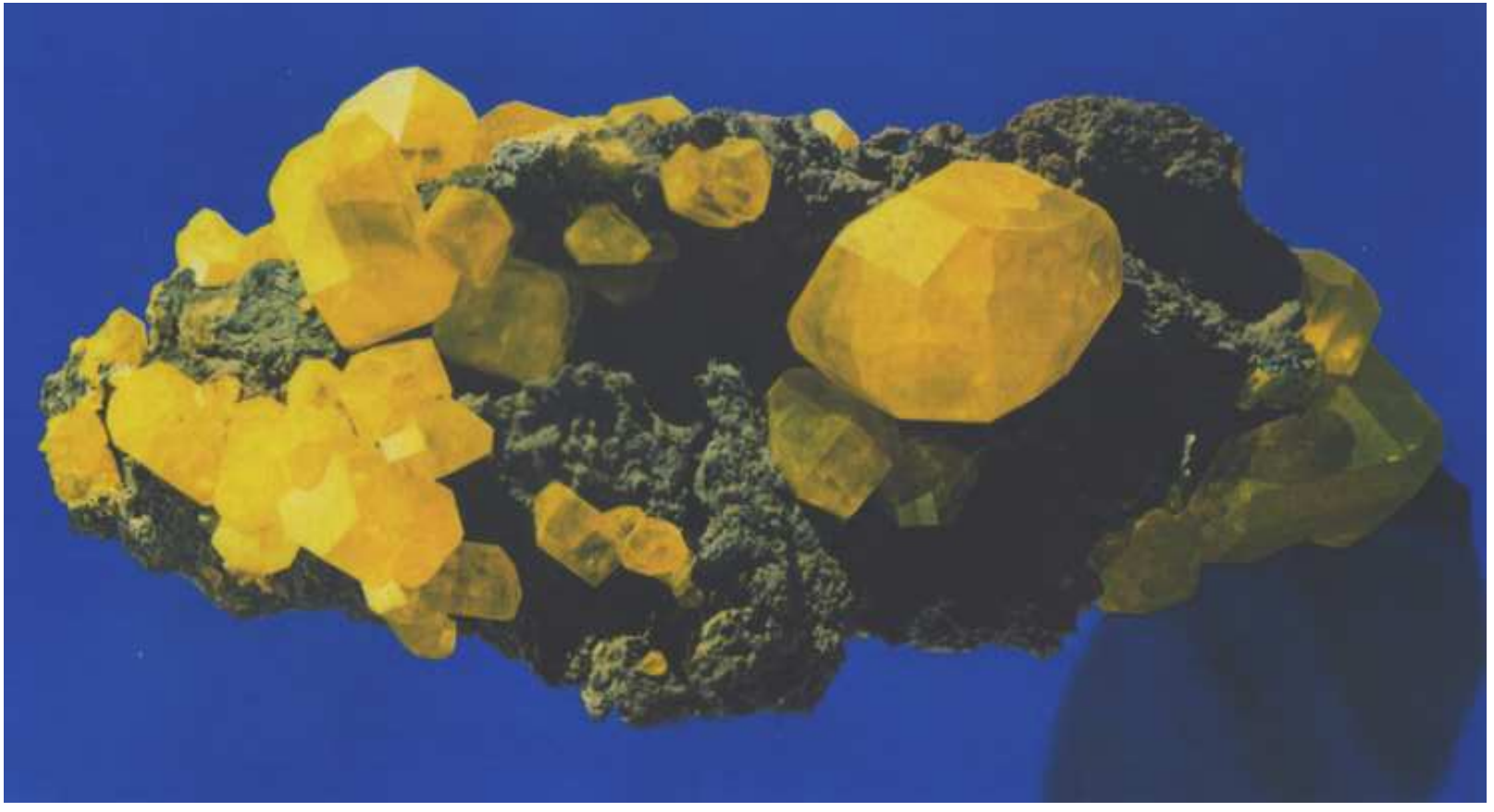
where

$$\langle \eta_\mu(\vec{x},t)\rangle = 0$$

and (generalized Einstein-Stokes/fluctuation-dissipation)

$$\langle \eta_\mu(\vec{x},t)\eta_\nu(\vec{x}',t')\rangle = -2M_{\mu\nu}k_bT\delta(\vec{x}-\vec{x}')\delta(t-t')$$

Reference: Section 8.6.3 *Principles of condensed matter physics*,Chaikin and Lubensky(1995).

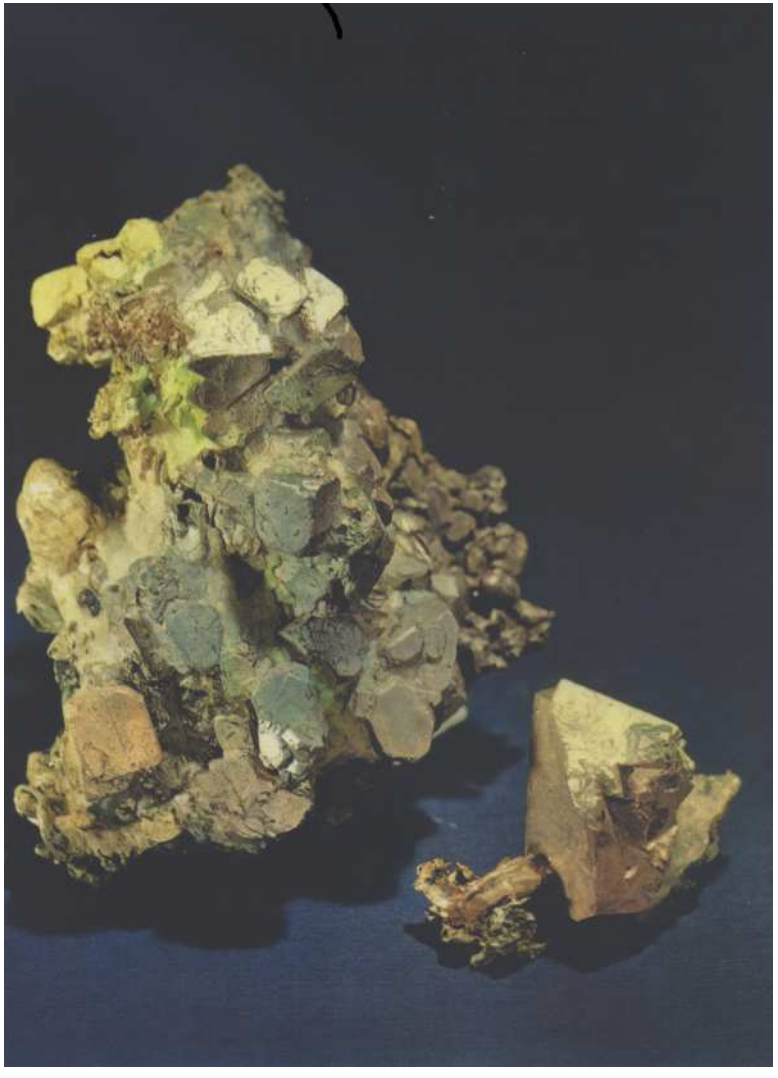


30.7 cm×13.2 cm

Au

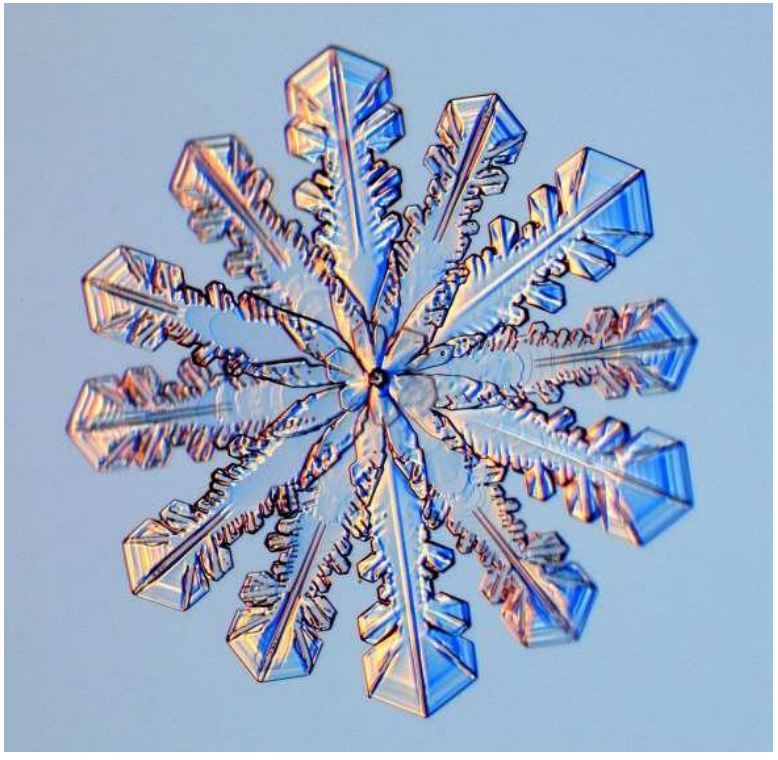
6.1 cm×12.7 cm

Ag



4.9 cm×6.5 cm

Snowflakes



http://www.its.caltech.edu/~atomic/snowcrystals/class/class.htm

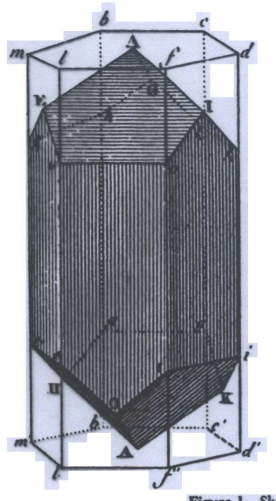


Figure 1 Sketch of a crystal, selected at random from an early mineralogy treatise. (Haüy.)

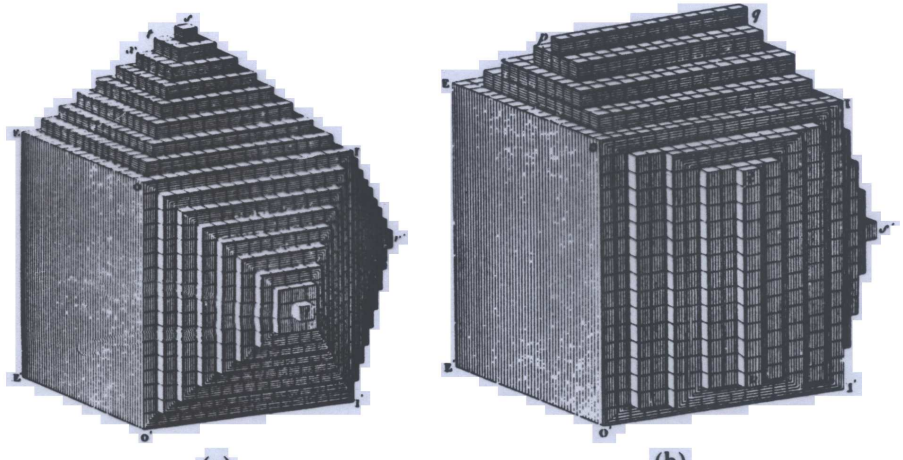


Figure 2 Relation of the external form of crystals to the form of the elementary building blocks. The building blocks are identical in (a) and (b), but different crystal faces are developed. (Haüy, from the atlas to the 1822 edition of his *Traité de cristallographie*.)

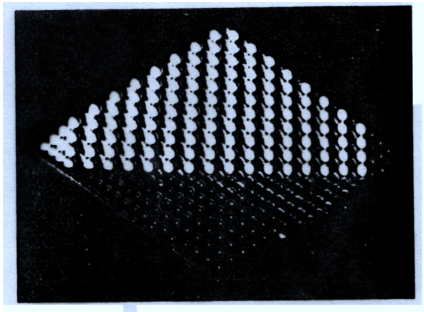


Figure 21a A (110) plane of an fcc crystal structure, as built up from (100) layers. (This and the accompanying photographs are by J. F. Nicholas, *Atlas of models of crystal surfaces*, Gordon and Breach, 1965).

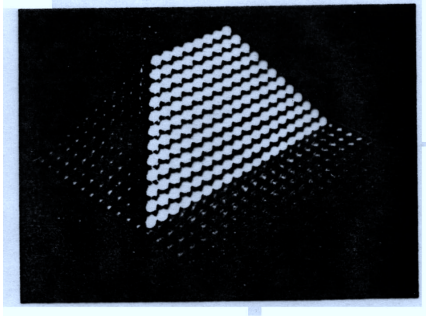


Figure 21b A (111) plane of an fcc crystal structure, based on (100) layers.

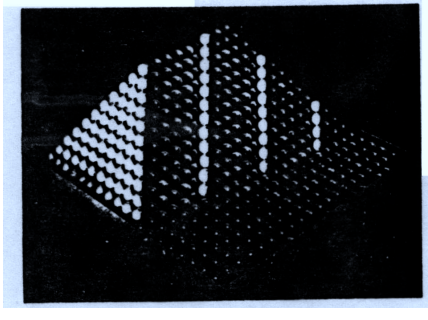
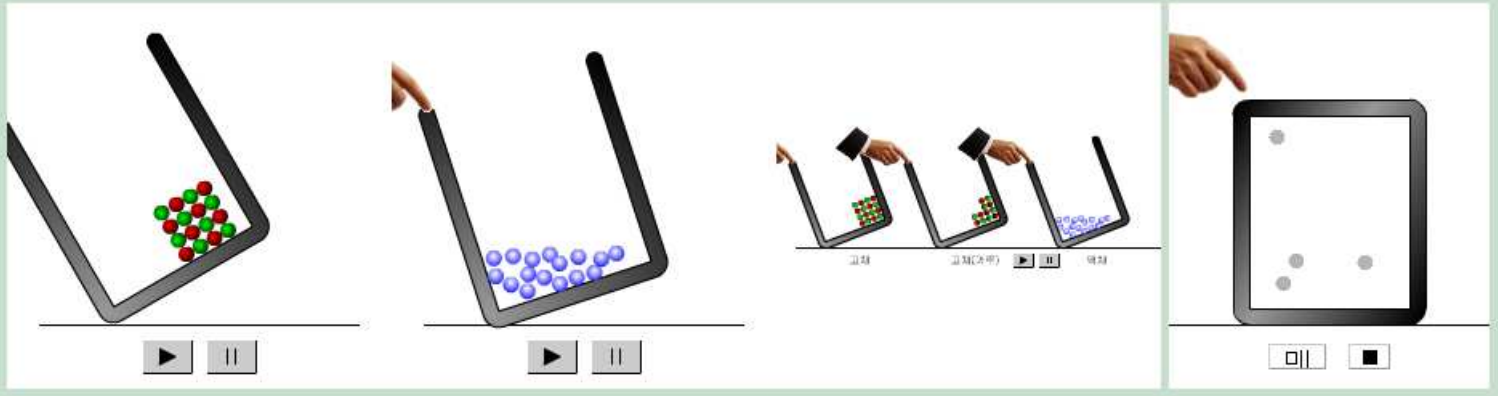


Figure 21c A (322) plane of an fcc crystal structure, based on (100) layers. The concentration of atoms tends to be lower in planes of high indices than in planes of low indices.

Phases of Matter in Containers

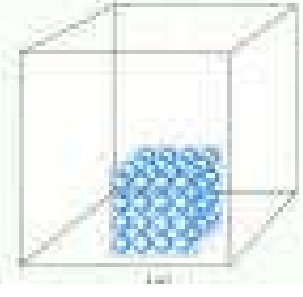


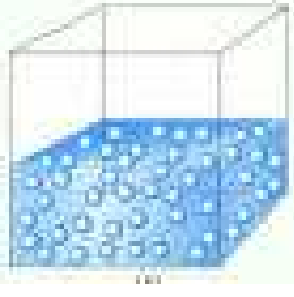
These shockwave and java animations show how:

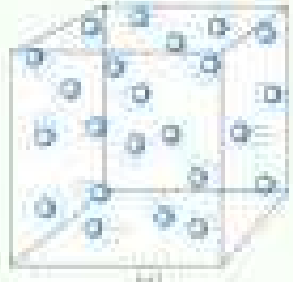
Gases fill and conform to the shape of the container

Liquids do not fill, but conform to the shape of the container

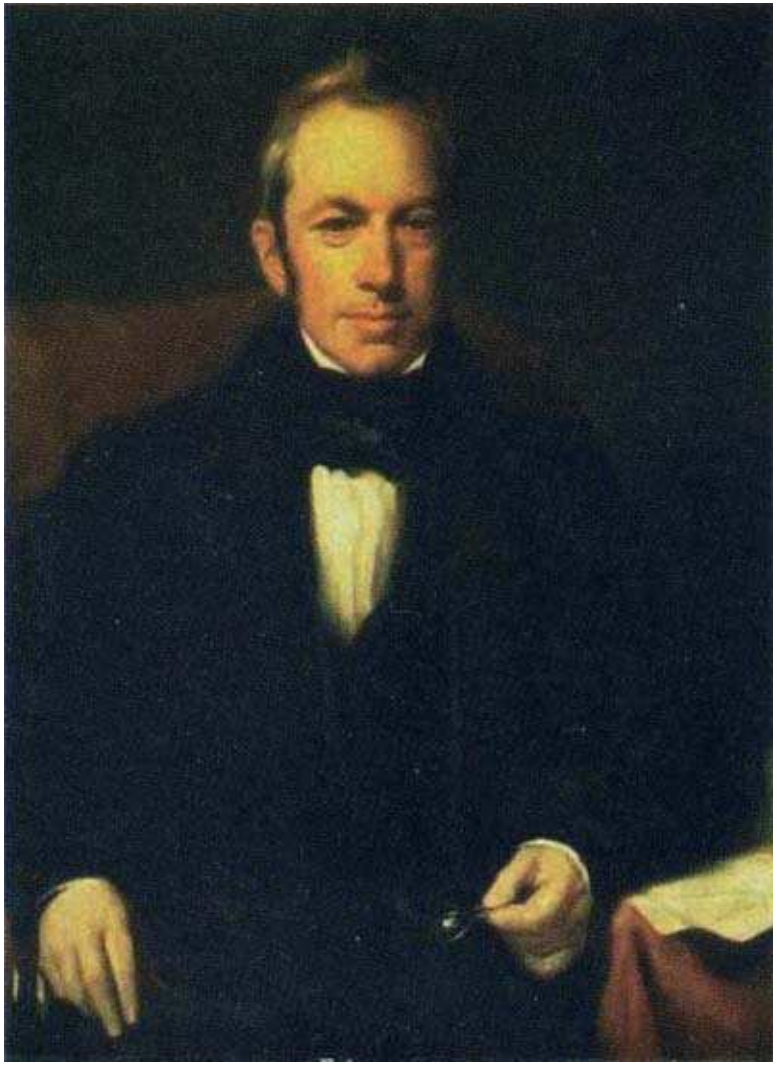
Solids retain there shape, neither filling nor conforming to the container shape

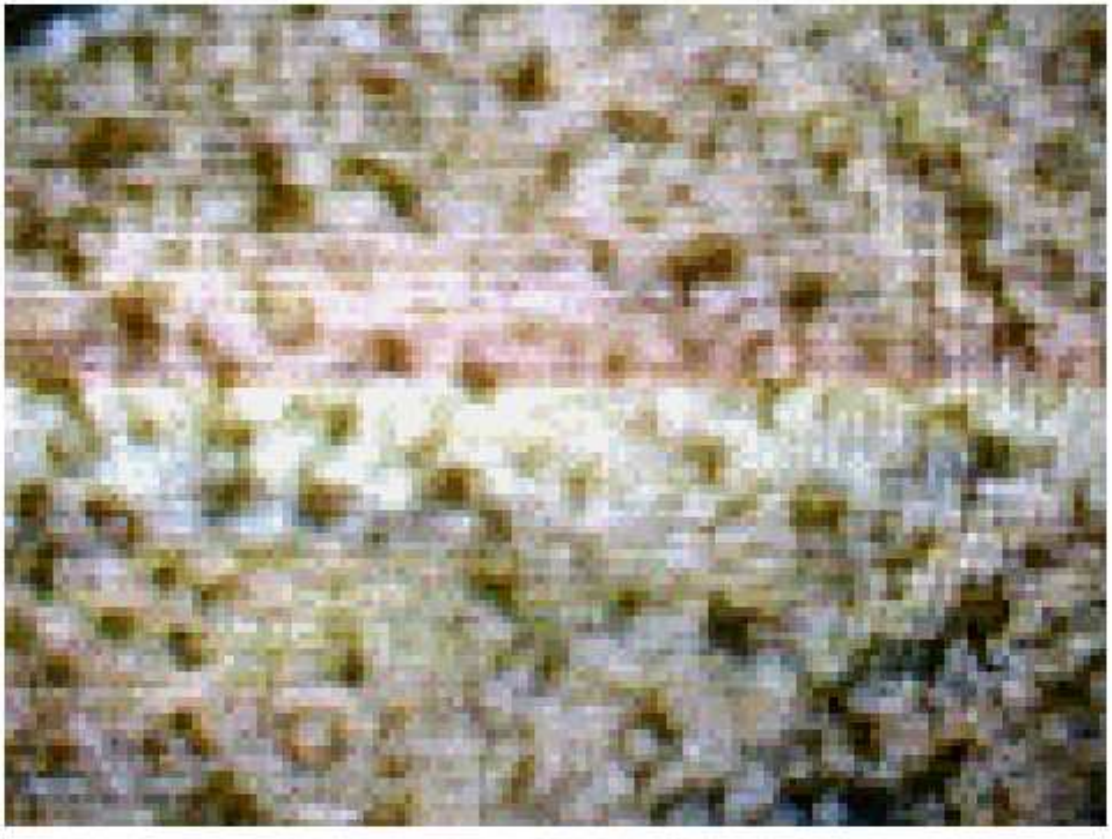


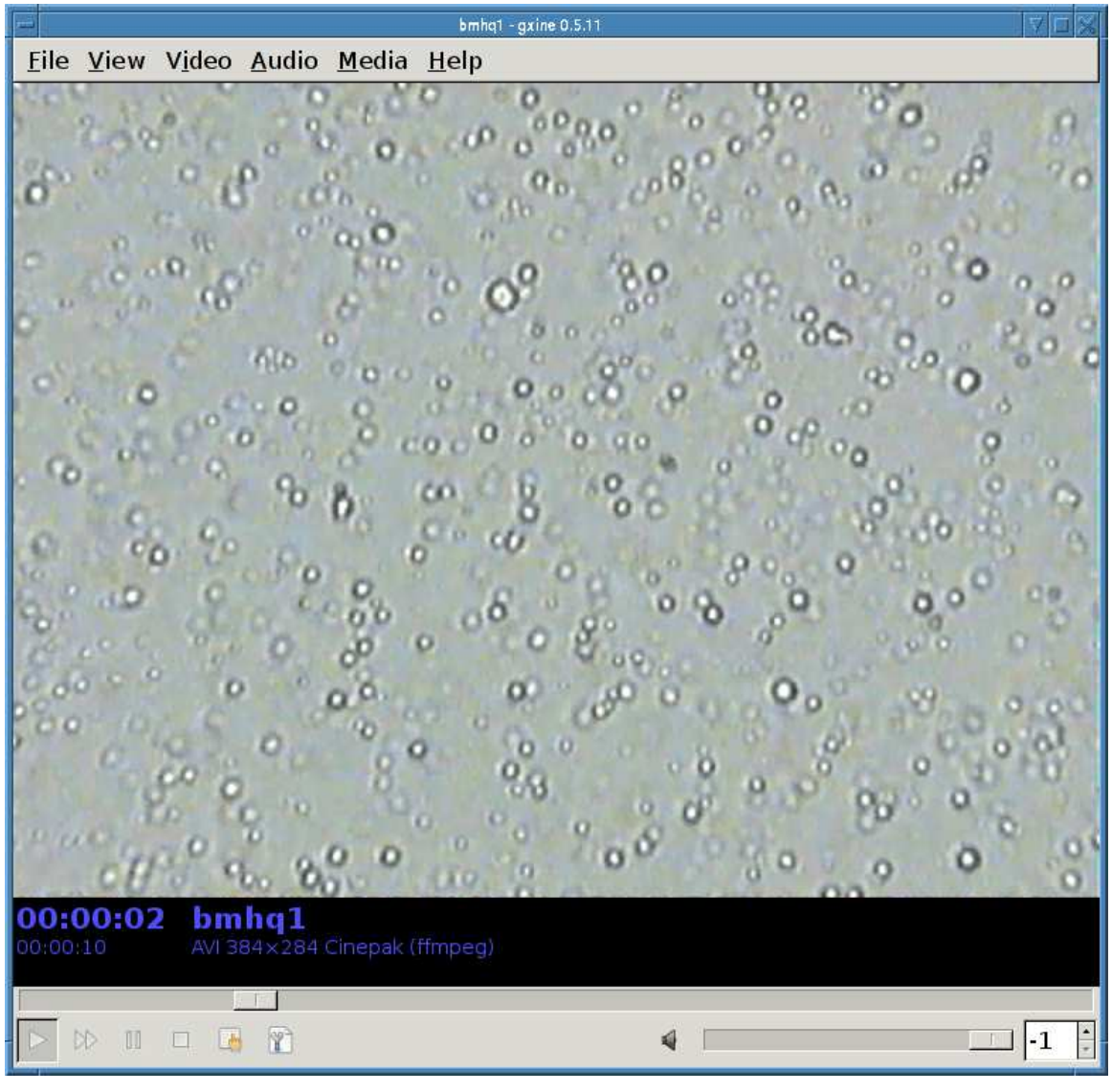




Robert Brown (in 1827)



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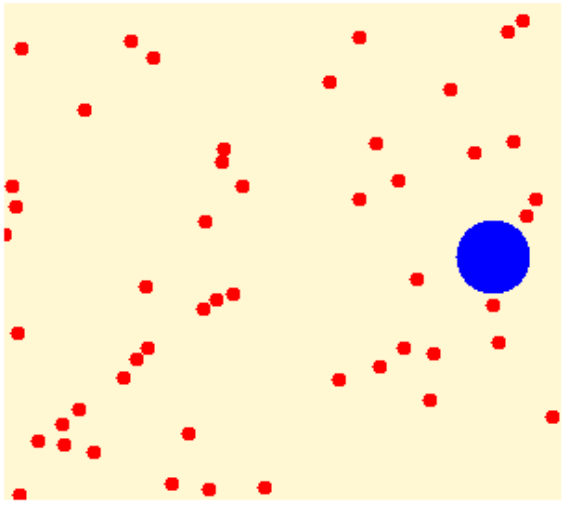
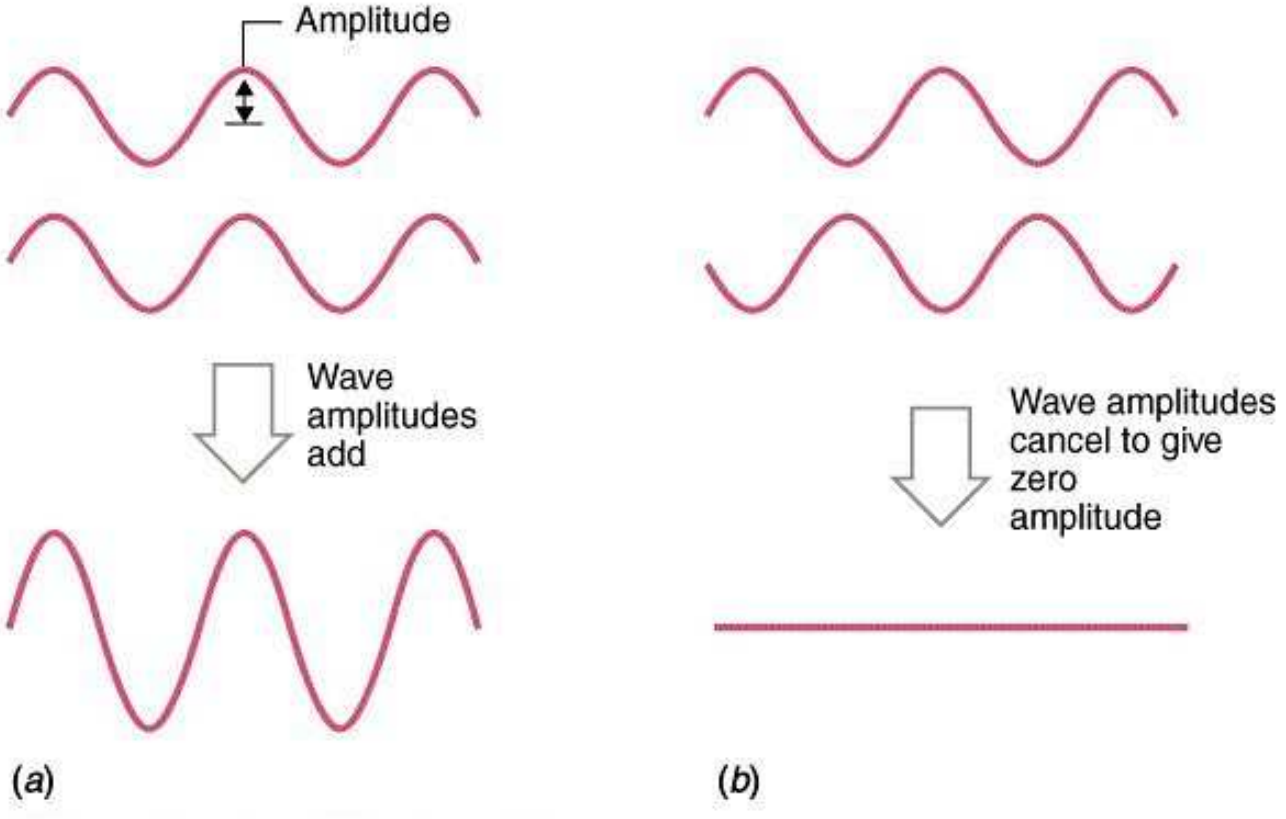
Albert Einstein (in 1905)



Start Reset

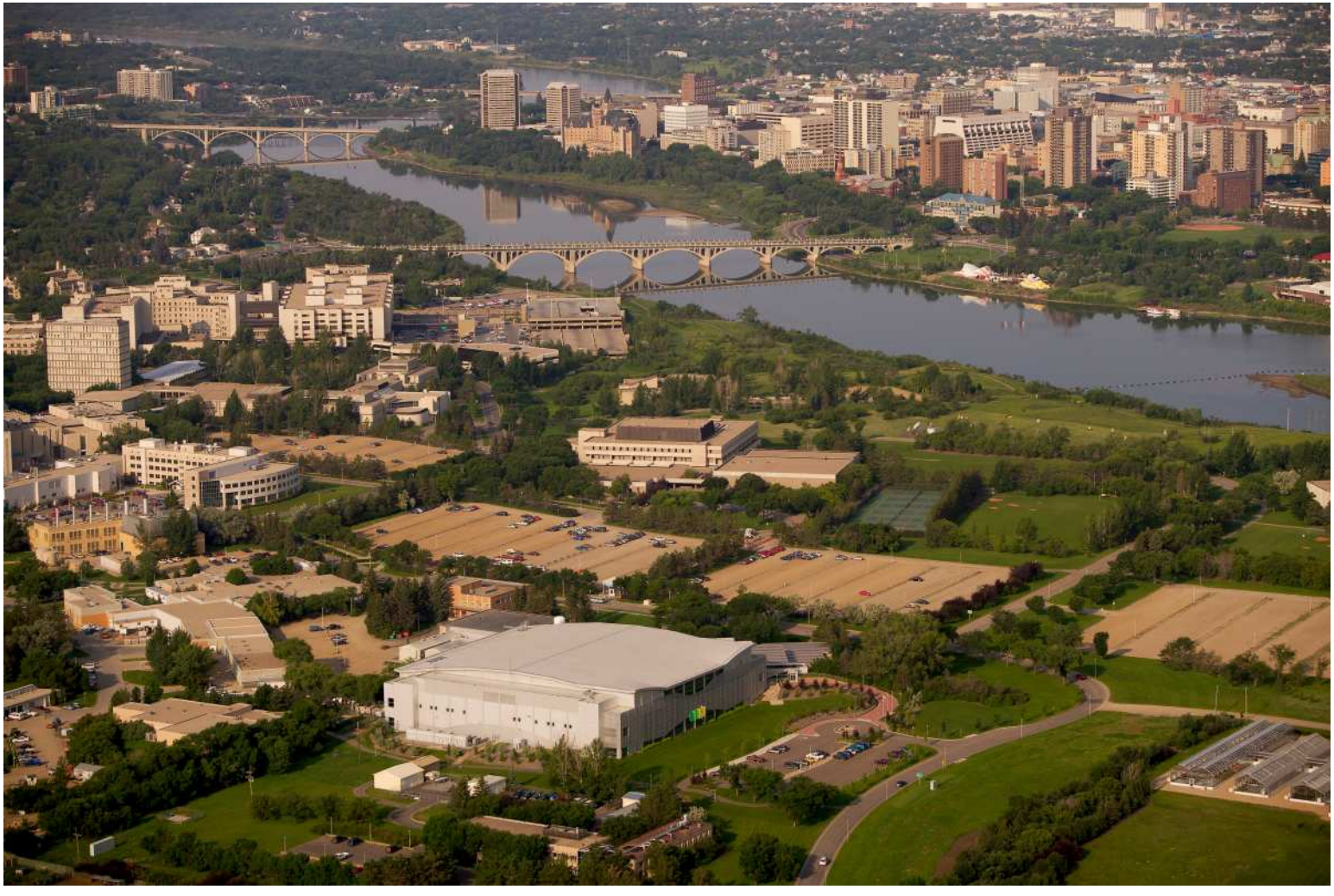
Constructive and destructive interference

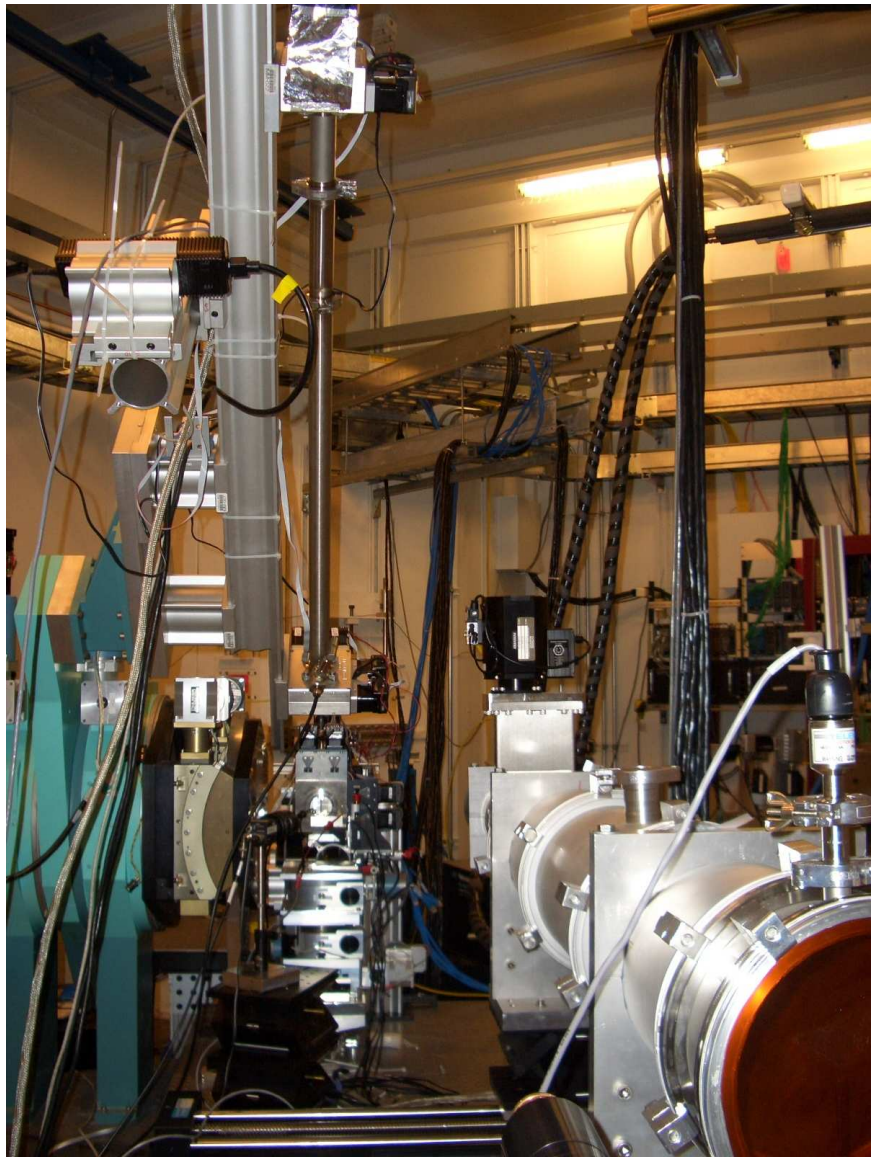


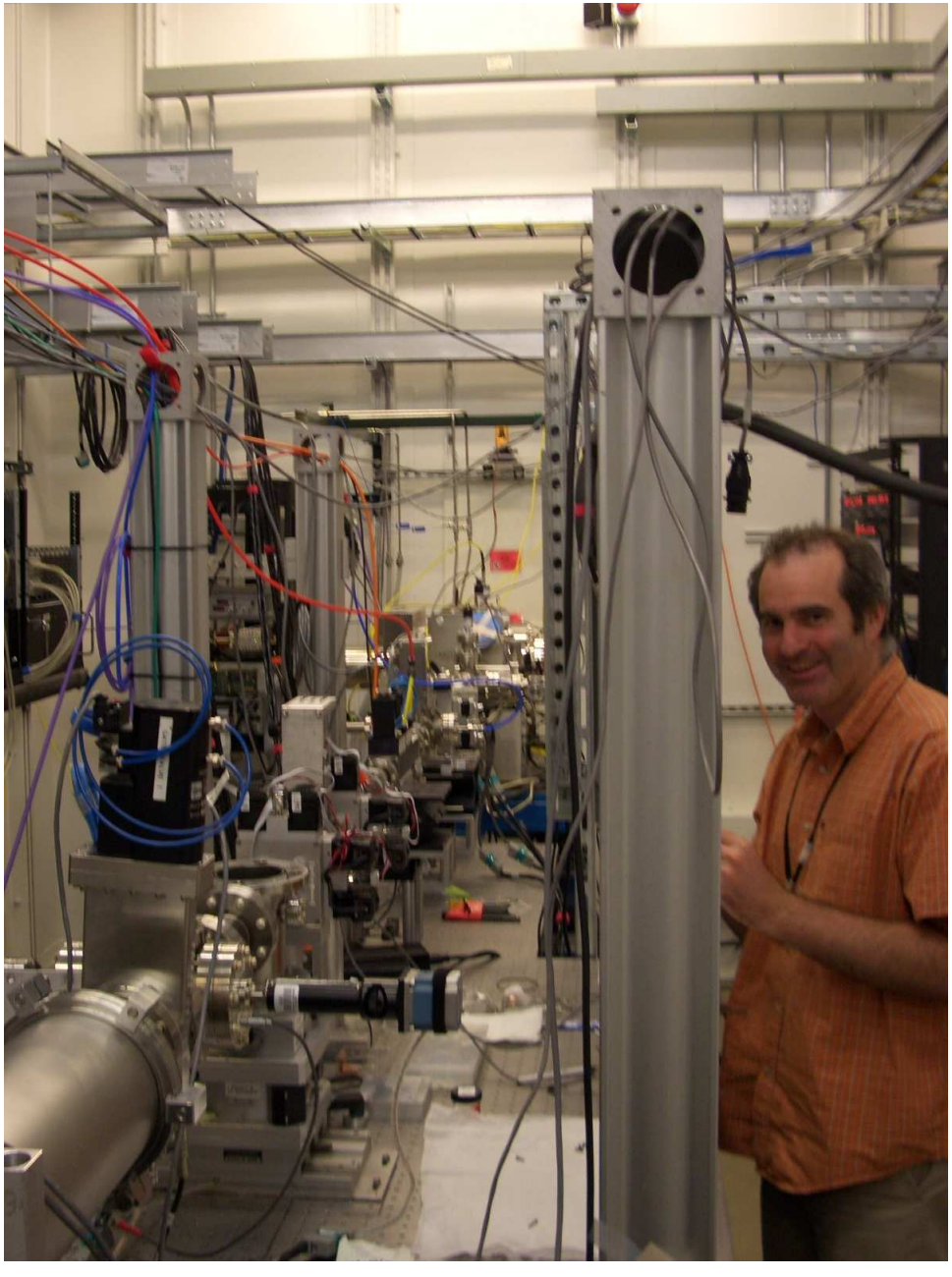
ESRF, Grenoble, France

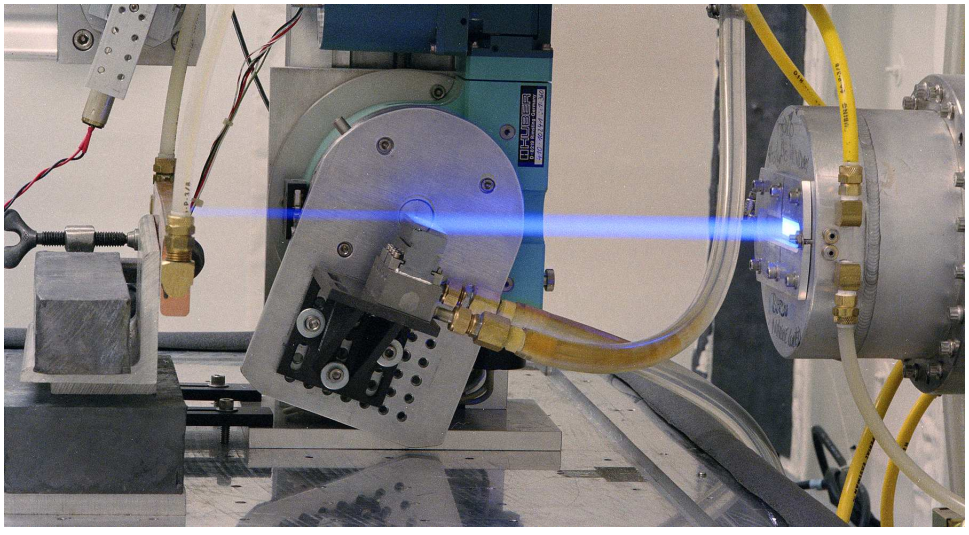
APS, Chicago, USA

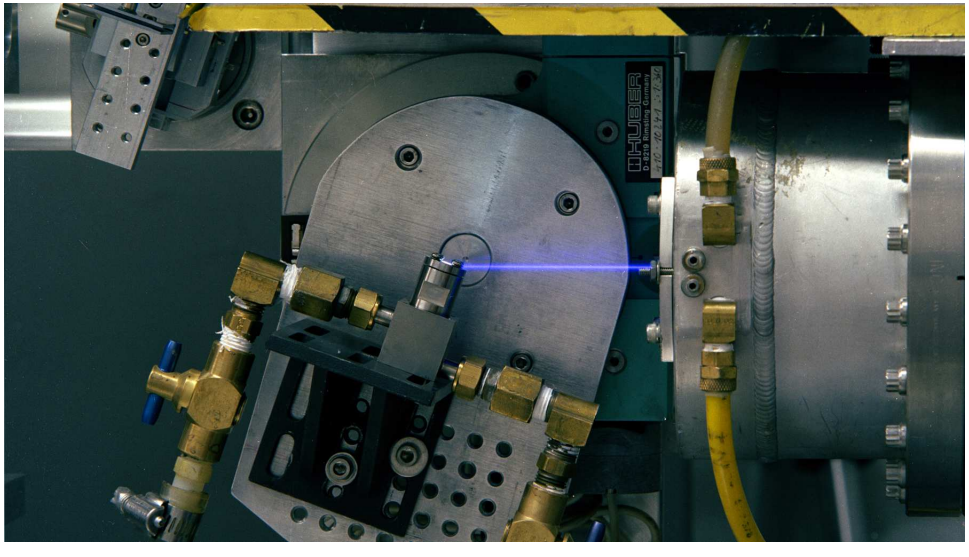
CLS, Sasktoon, SK





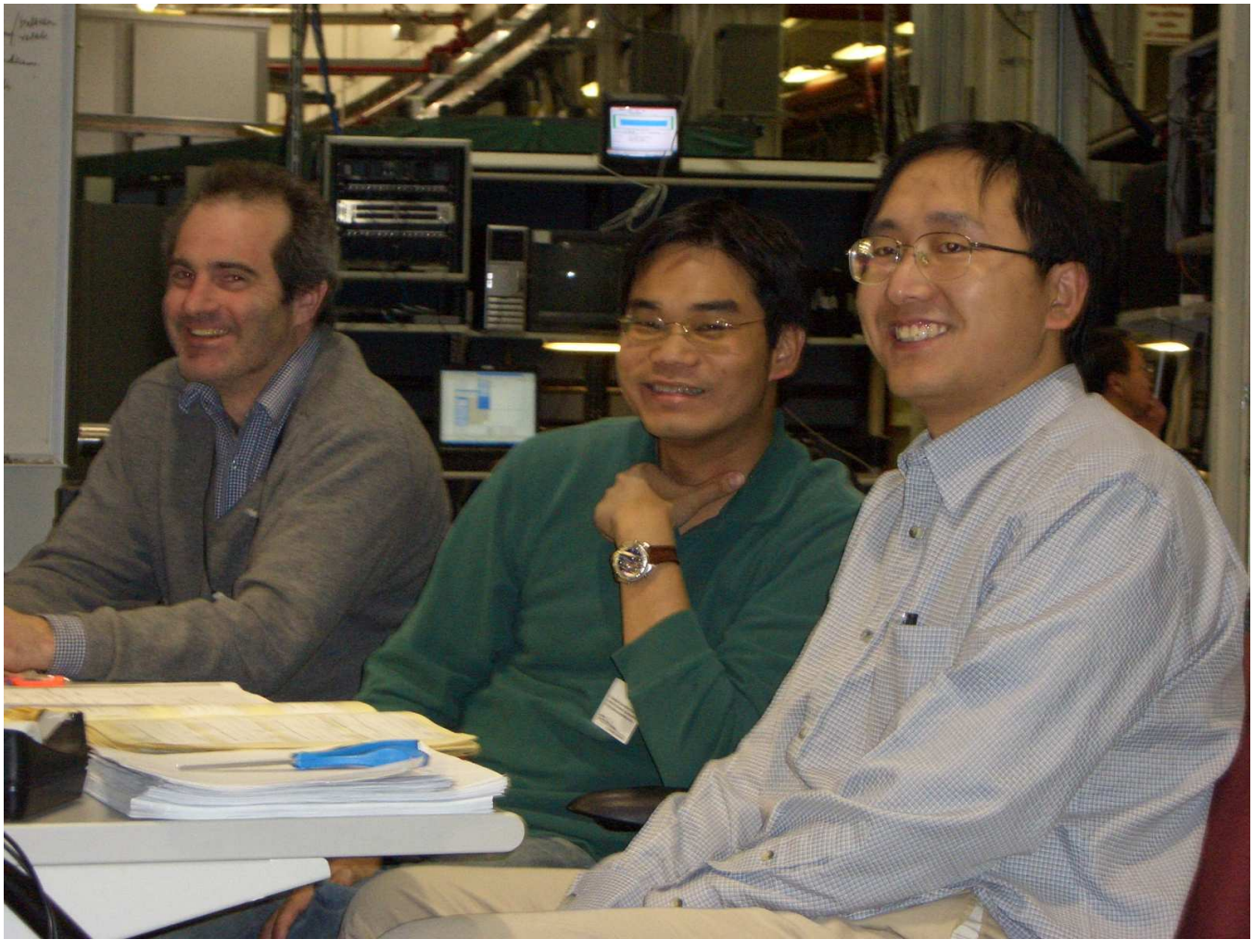


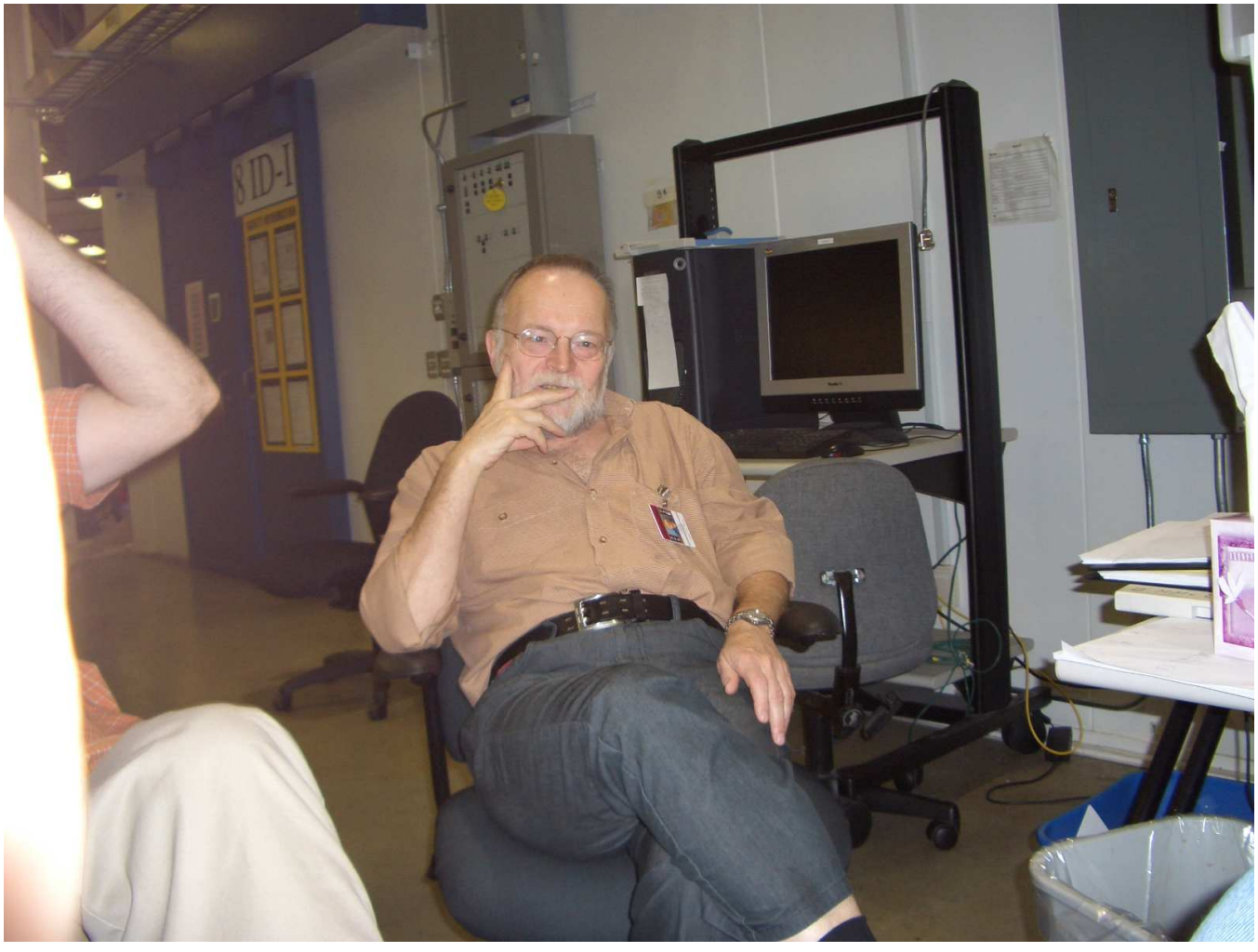




Beamline X25, NSLS


TROIKA
TROIKA

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DANGER!!
MELTDOWN IMMINENT!