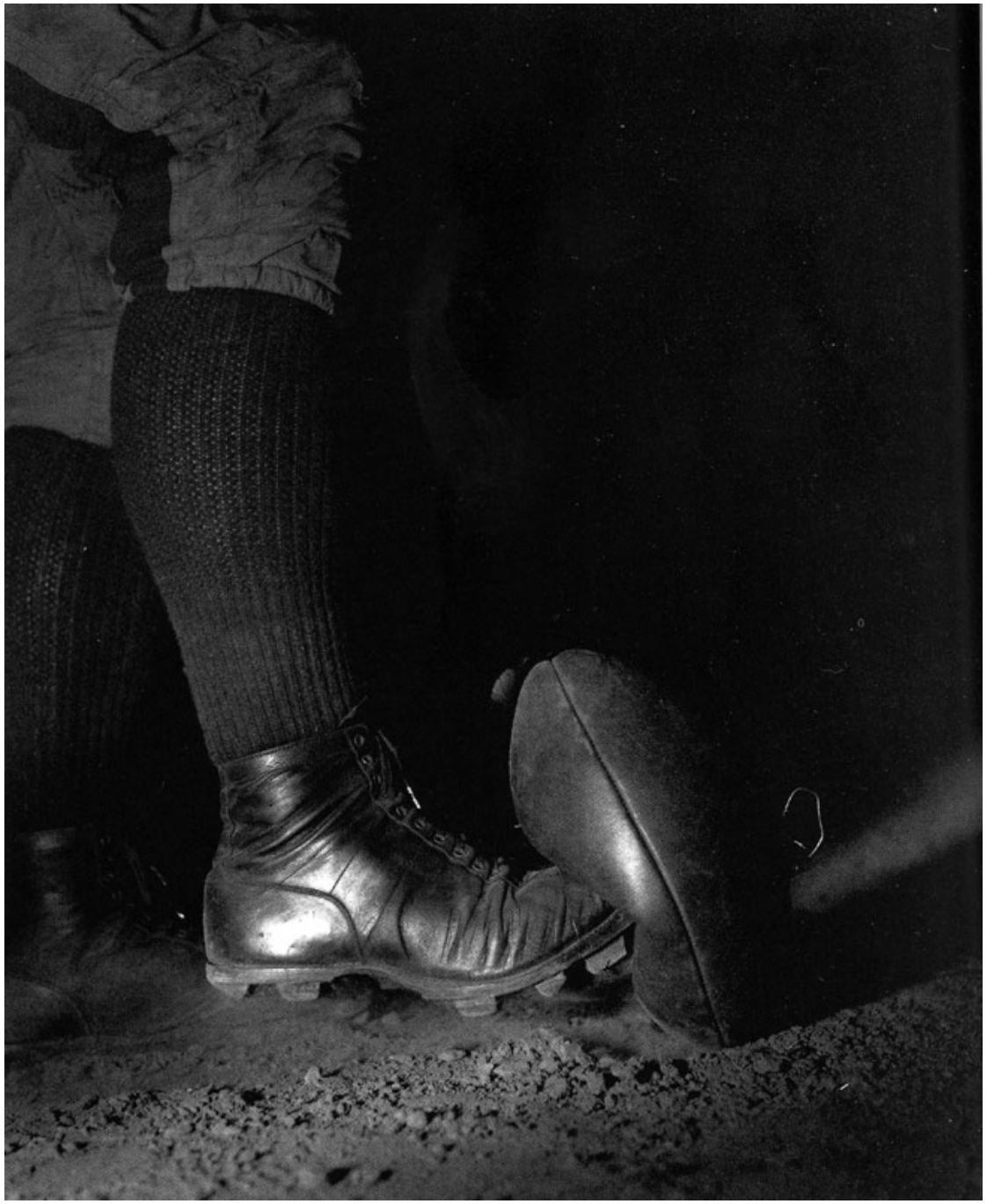
MOMENTUM

&

Collisions

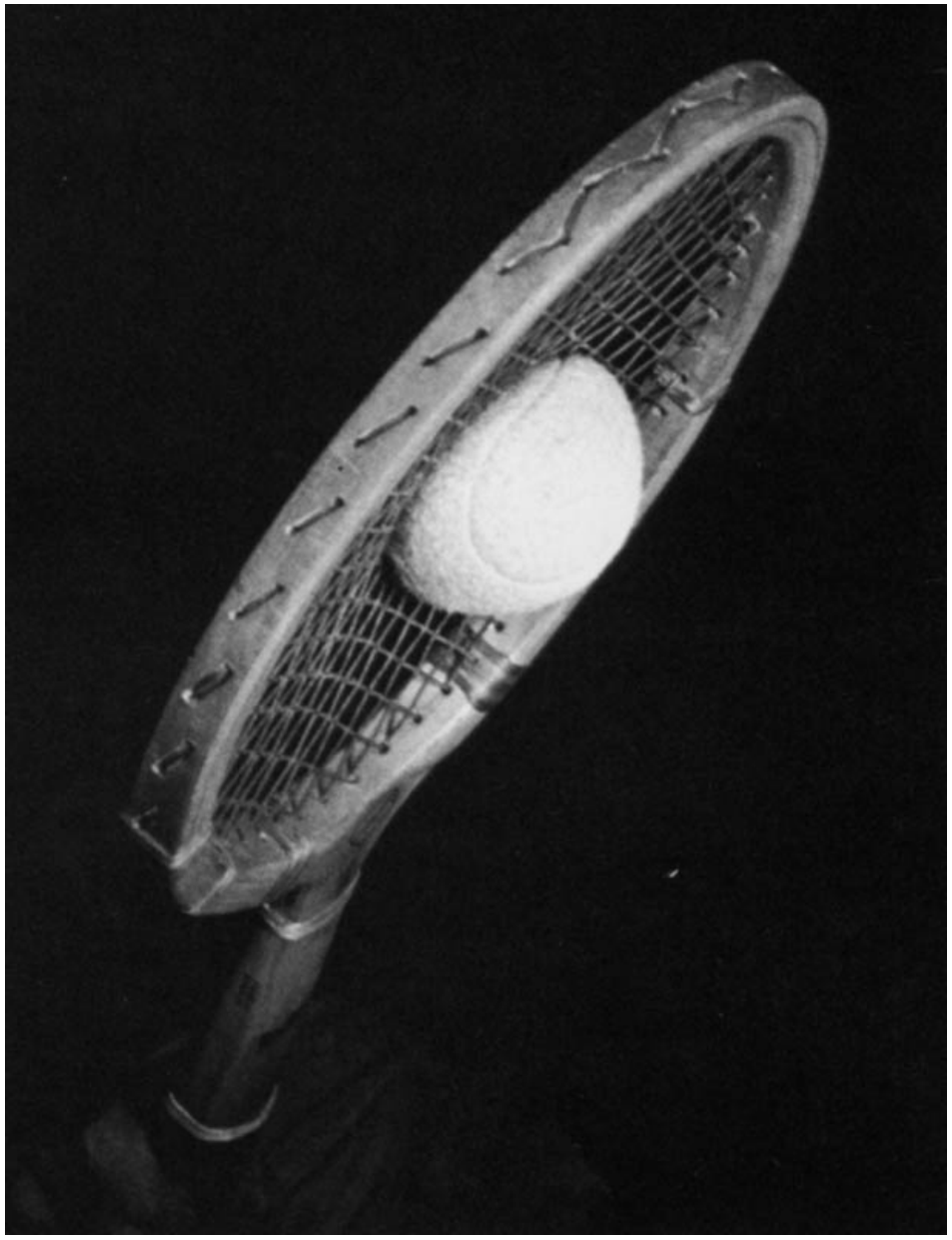


WES FESLER KICKING A FOOTBALL – 1934

Harold E. (Doc) Edgerton

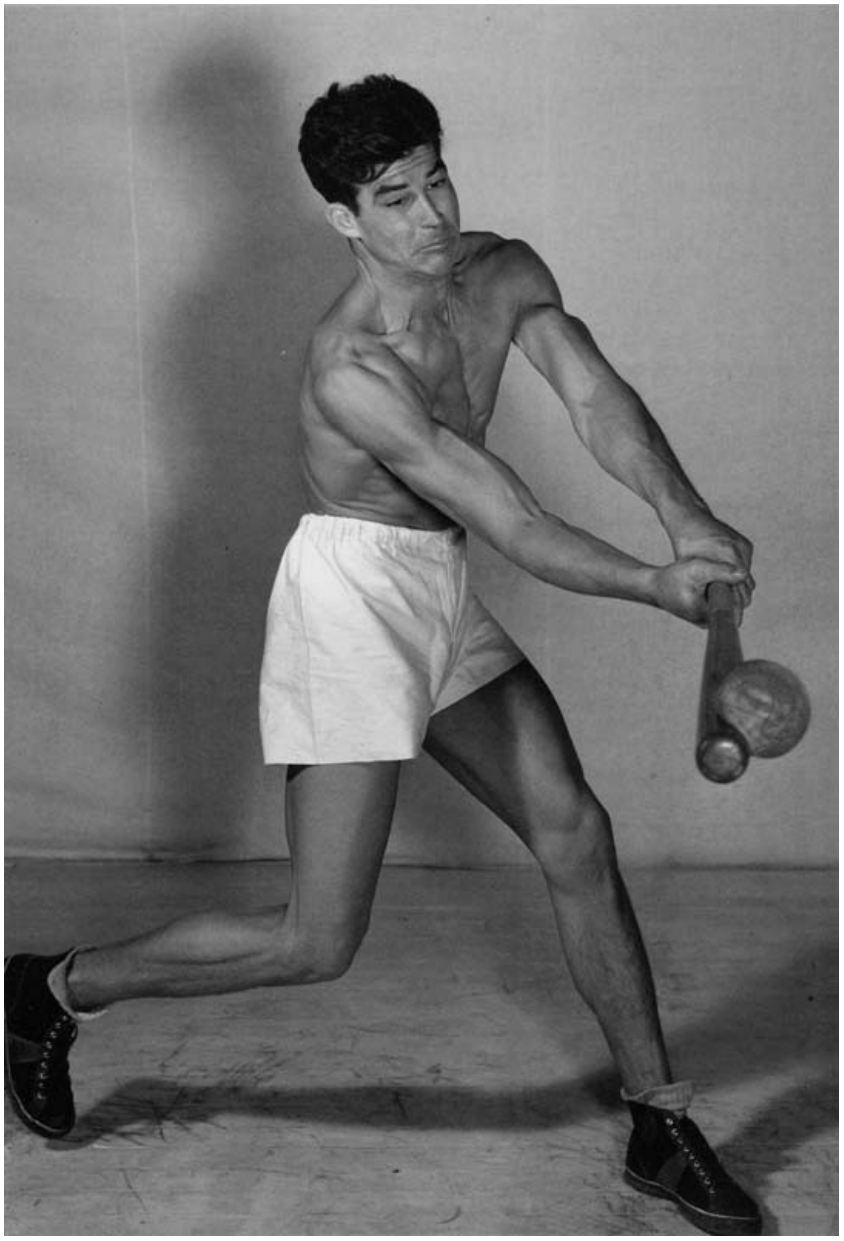
DRIVING THE GOLF BALL – 1935

Harold E. (Doc) Edgerton



TENNIS BALL IMPACT – 1938

Harold E. (Doc) Edgerton



SOFTBALL BATTER – 1938

Harold E. (Doc) Edgerton

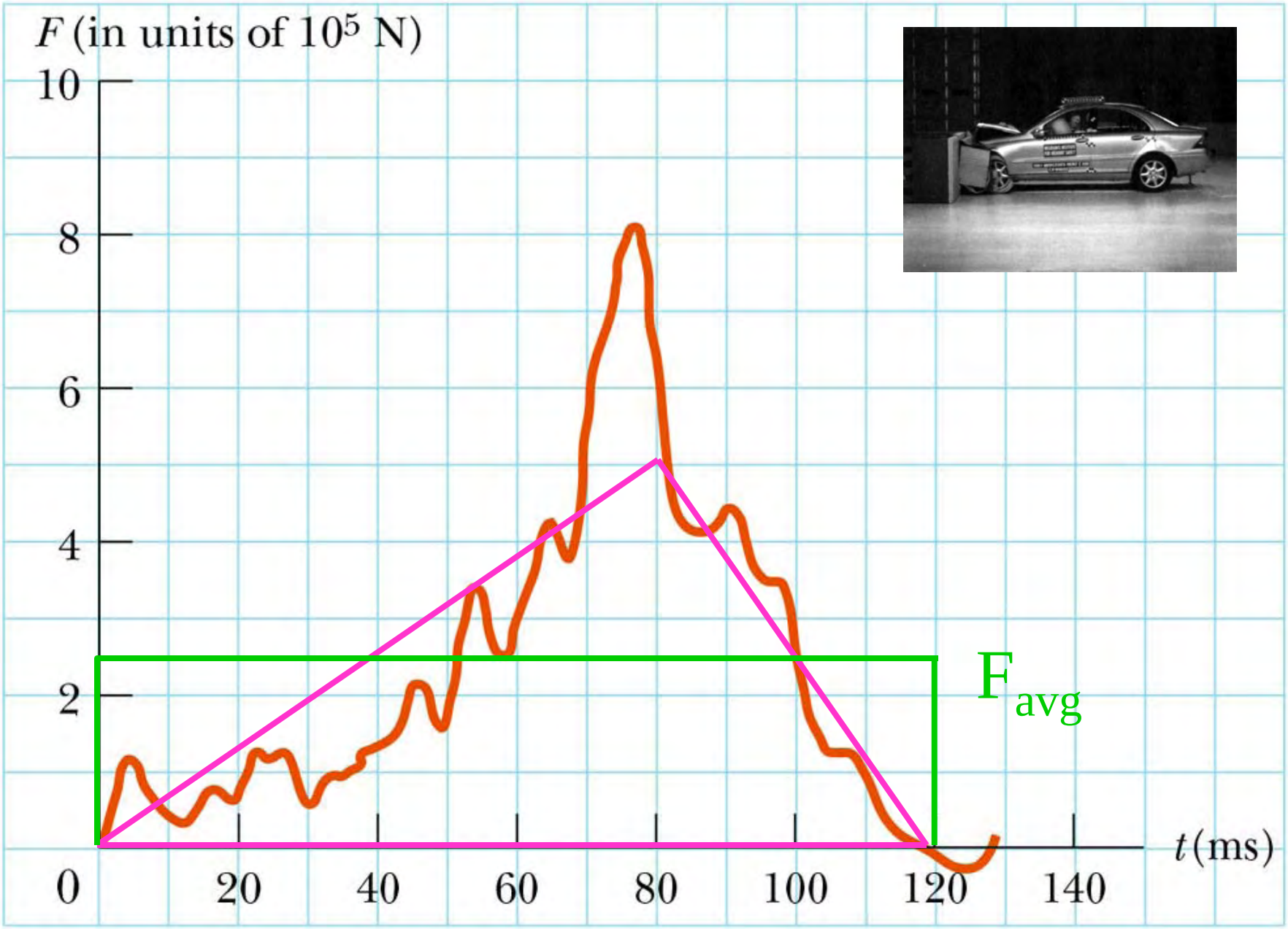
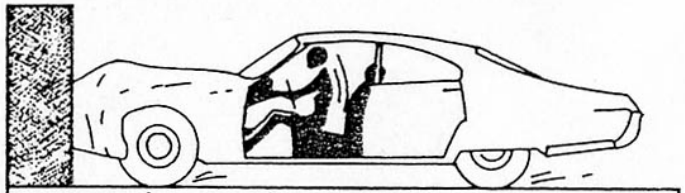


Figure 14–1. Effect of a 30-mph head-on collision of an unbelted driver.

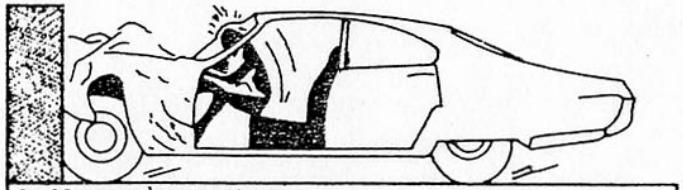
0.000 seconds—car hits barrier

On impact, the car begins to crush and to slow down. The person inside the car has nothing to slow him down so he continues to move forward inside the car at 30 mph.



0.050 seconds—car crushes

The car slows down as the crushing of the front end absorbs some of the force of the collision. The person inside is still moving forward at 30 mph.

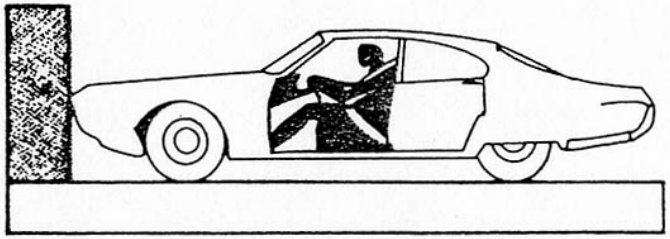


0.100 seconds—car stops
0.120 seconds—person hits car interior

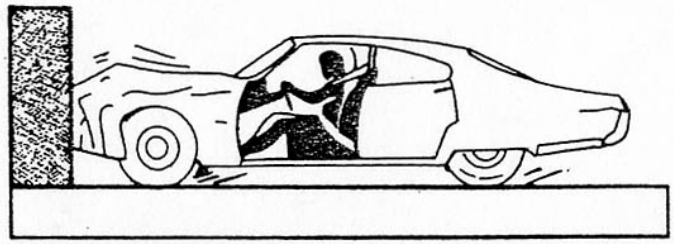
One-fiftieth of a second after the car has stopped, the person slams into the dashboard and windshield. This is the human collision. In the car's collision it takes 1/10 of a second to stop; in the human collision it takes only 1/100 of a second.

SOURCE: *The Human Collision*, 2d ed. (Toronto, Ontario: Ministry of Transportation and Communications, 1976).

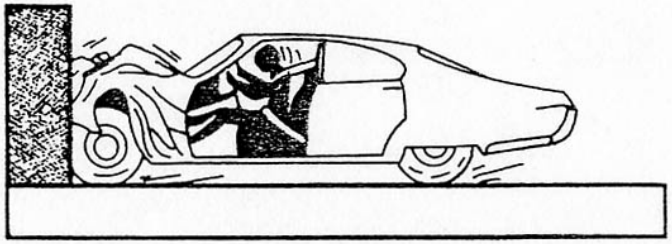
Figure 14–2. Effect of a 30-mph head-on collision when driver wears a seat belt.



On impact, the car begins to crush and to slow down.



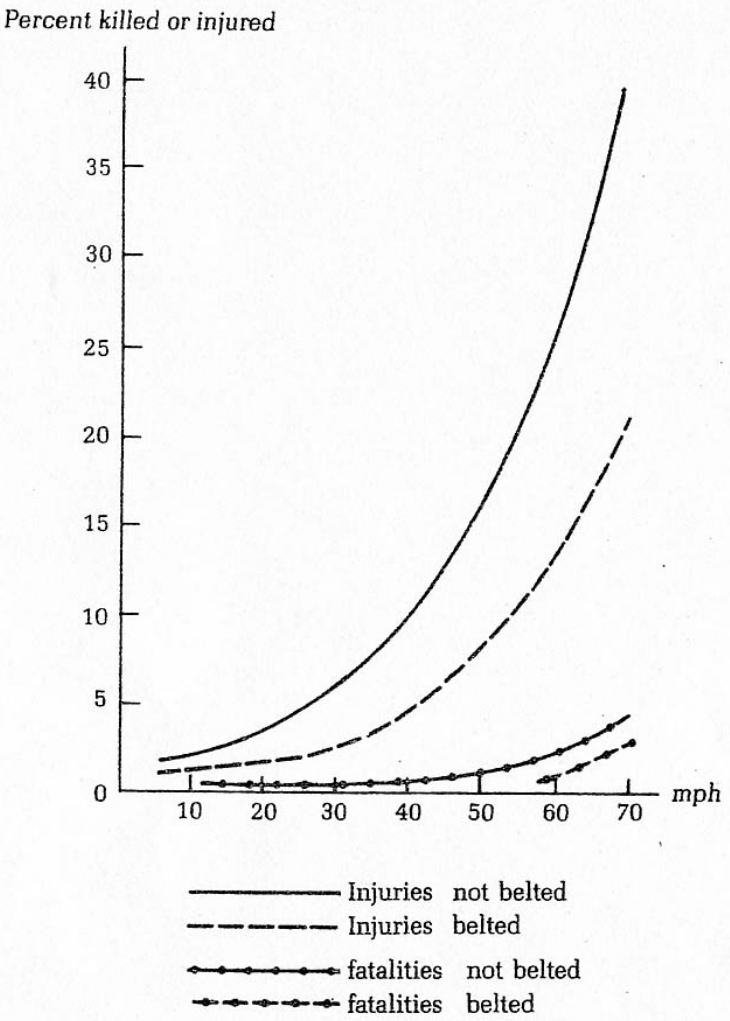
As the car slows down, the person moves forward until the seat belts restrain him. The belts keep him in his seat and keep his head and chest from striking the car interior.



Being fastened to the framework of the car, belted occupants are able to "ride down" the collision as part of the car. They are able to take advantage of the car's slower stop, as it crushes and absorbs energy. For belted people there is no human collision.

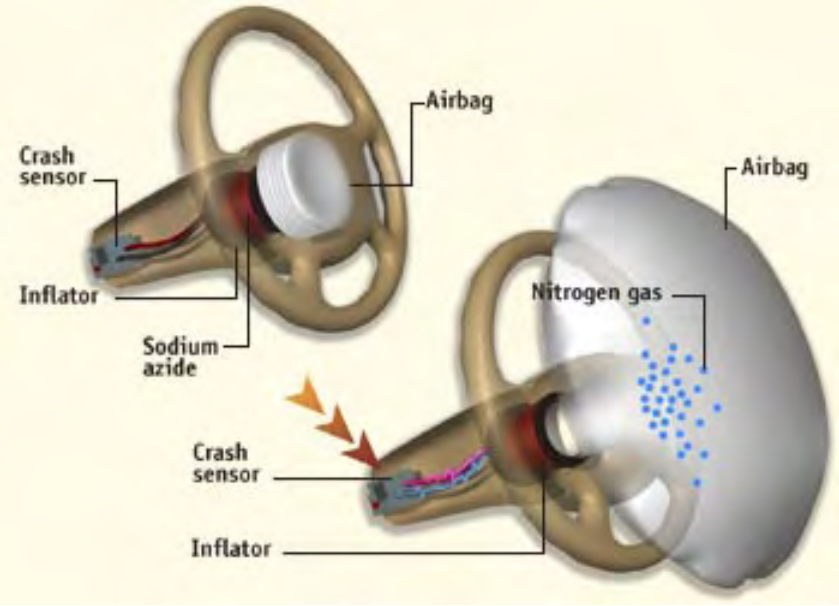
SOURCE: *The Human Collision*, 2d ed. (Toronto, Ontario: Ministry of Transportation and Communications, 1976).

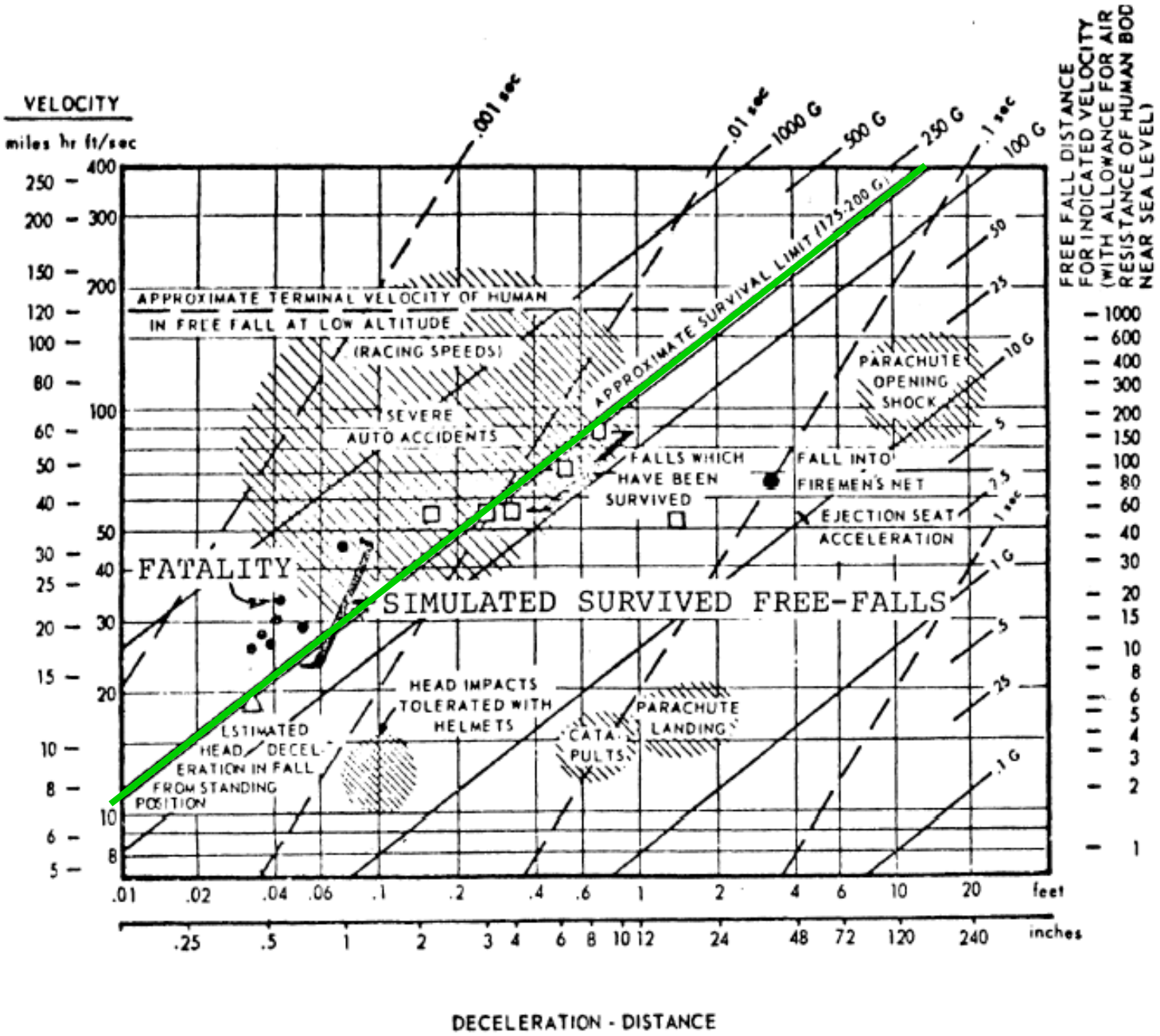
Figure 14-3. Injuries and fatalities at various speeds, with and without seat belts.



A Swedish study showed that belted people received about half as many injuries as unbelted people in collisions at all speeds.

SOURCE: *The Human Collision*, 2d ed. [Toronto, Ontario: Ministry of Transportation and Communications, 1976.]


Airbag
Crash sensor
Airbag
Inflator
Nitrogen gas
Sodium azide
Crash sensor
Inflator



DECELERATION - DISTANCE

Study of Impact Tolerance through Free-Fall Investigation
R.G. Snyder. D.R. Foust, & B.M. Bowman (1977)

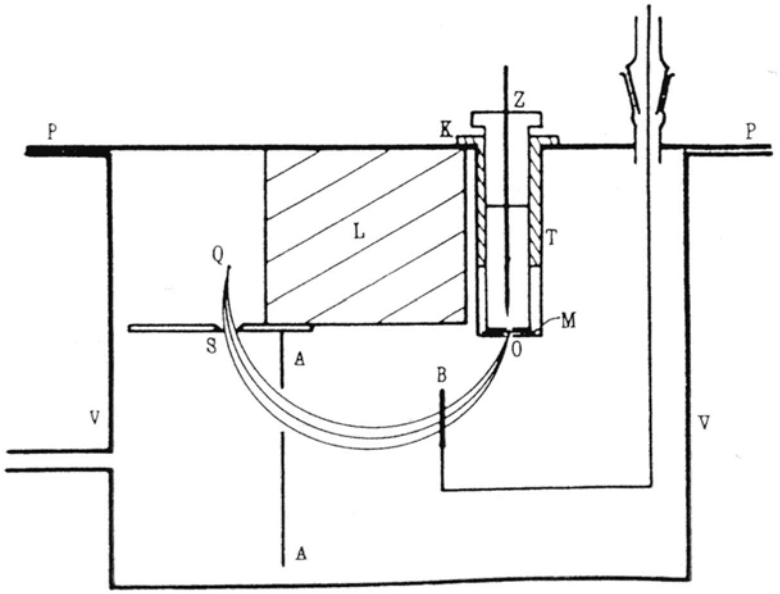
"[O]n the frigid 23rd of March, 1944, Flight Sergeant Nicholas Alkemade, an RAF rear gunner [had his bomber set afire] by a German night fighter on a raid over Hamburg. [H]e found that he was unable to reach his parachute, stowed forward in the flaming fuselage. Deciding he didn't care to burn alive, he jumped without a parachute just as the aircraft exploded above him. His altitude was 18,000 feet. Falling at a terminal velocity of about 120 mph during this 3 1/2 mile fall (which lasted about 90 seconds), he struck the snowy branches of a pine forest and then landed in less than 18 inches of snow, only twenty yards from the bare open ground. Incredibly, his only reported injuries consisted of superficial scratches and bruises, and burns received prior to the jump."

From "Terminal Velocity Impacts Into Snow", R. G. Snyder. Military Medicine 131, 1290-1298 (1966).


cellar image of the day
more like this at http://cellar.org/

$n \rightarrow p + e^-$

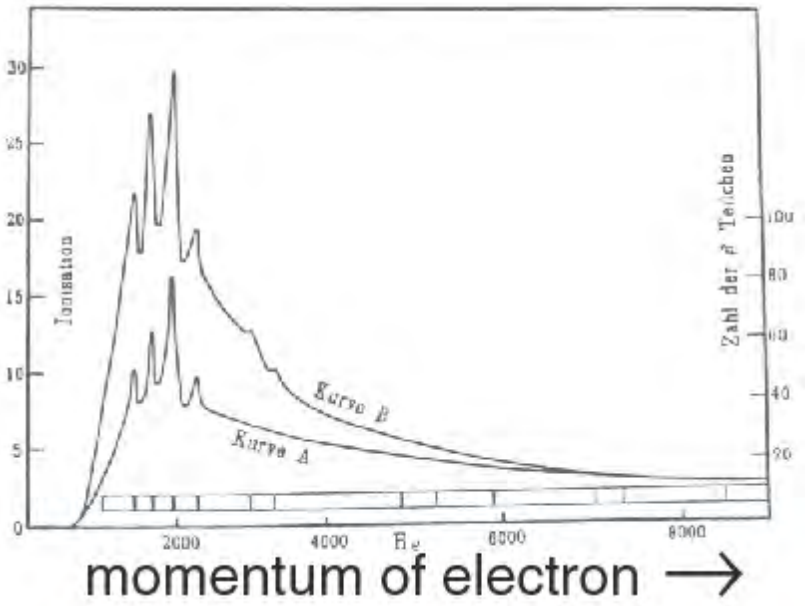
a two-body decay:
should result in a single
fixed momentum of the electron



Intensitätsverteilung im magnetischen Spektrum der β-Strahlen von Radium B + C;
von J. Chadwick.

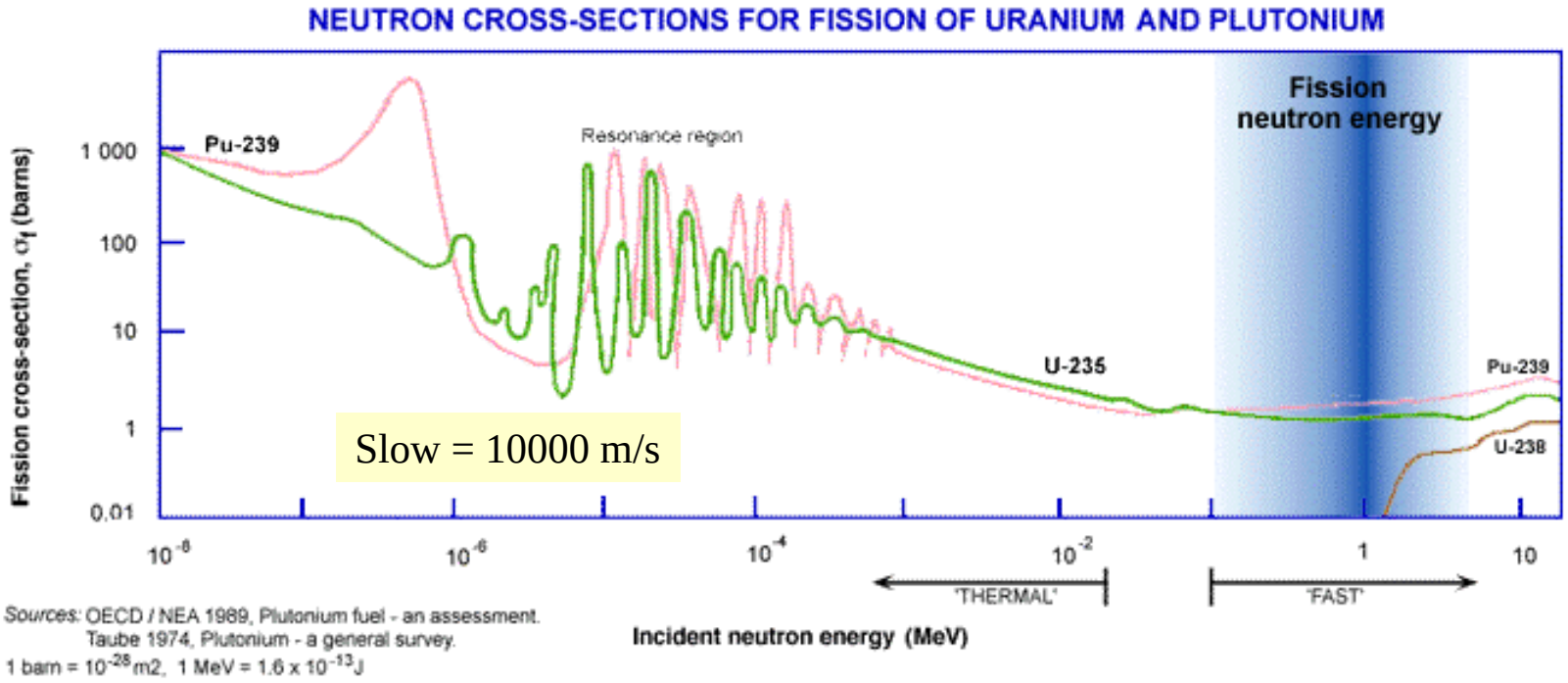
(Mitteilung aus der Physikalisch-Technischen Reichsanstalt.)
(Eingegangen am 2. April 1914.)

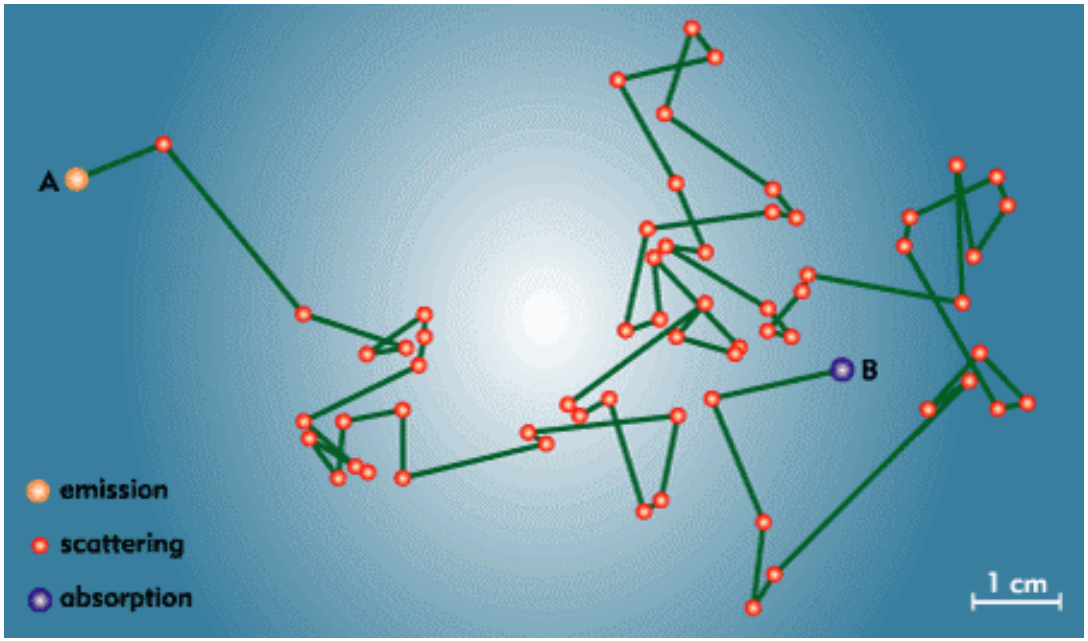
Die Versuche von HAHN, v. BAEYER und MEITNER [1]) haben gezeigt, daß die β-Strahlung der meisten radioaktiven Substanzen aus einer Reihe von Gruppen homogener β-Strahlen besteht. Im besonderen haben die Messungen von DANYSZ [2]) und RUTHERFORD

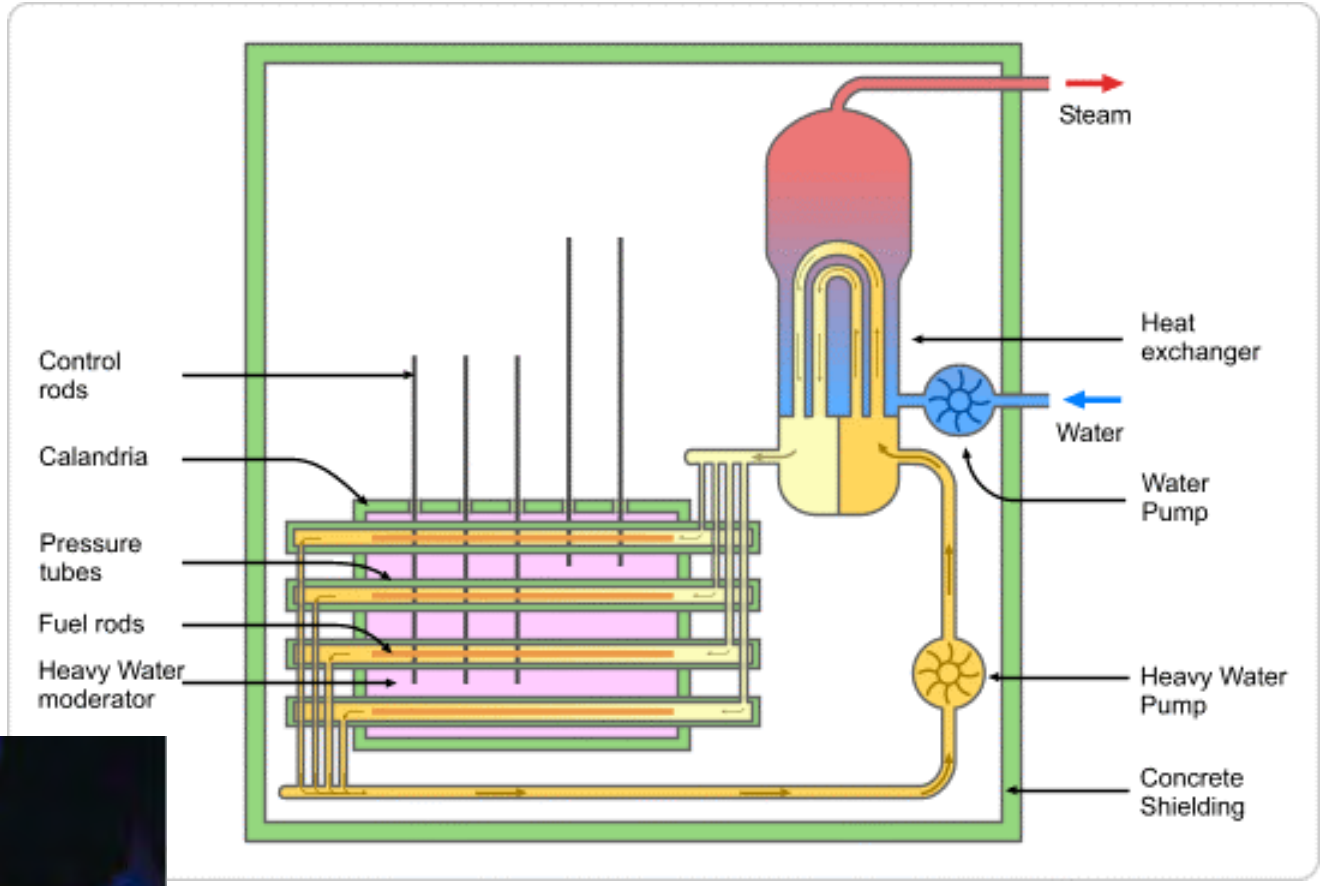


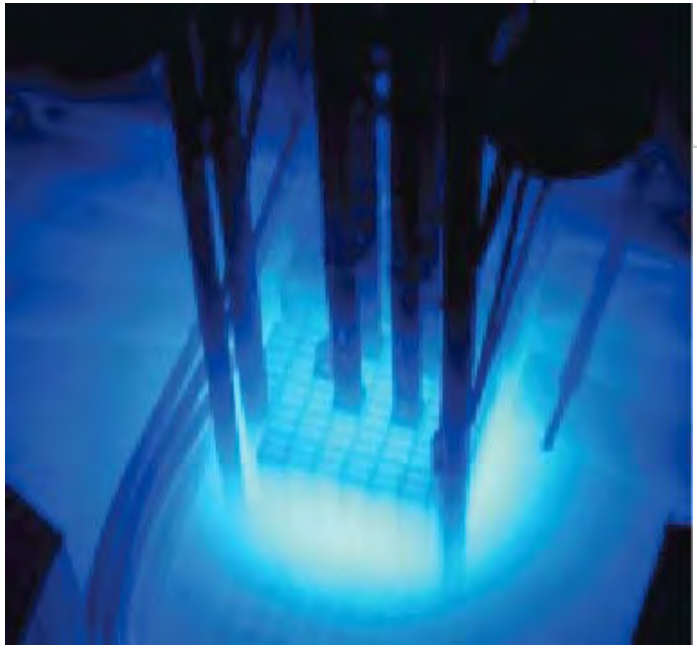
$n \rightarrow p + e^- + \nu$

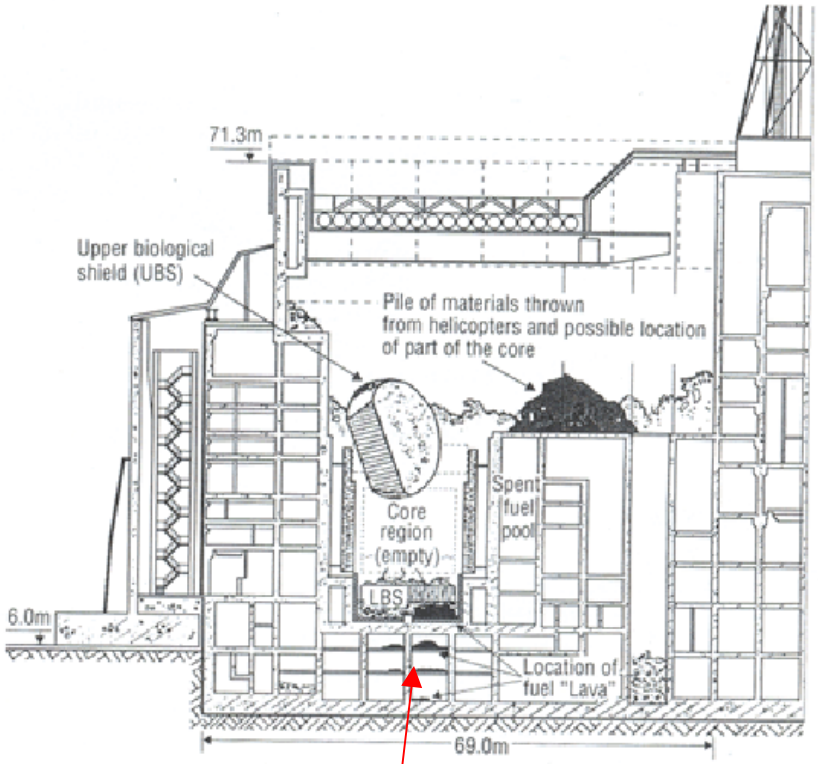
a lightweight neutrino can share energy with
the electron and explain the continuous distribution.


NEUTRON CROSS-SECTIONS FOR FISSION OF URANIUM AND PLUTONIUM
Fission cross-section, σf (barns)
1 000
100
10
1
0.01
Pu-239
Resonance region
Fission neutron energy
U-235
Pu-239
U-238
Slow = 10000 m/s
10-8
10-6
10-4
10-2
1
10
'THERMAL'
'FAST'
Incident neutron energy (MeV)
Sources: OECD / NEA 1989, Plutonium fuel - an assessment.
Taube 1974, Plutonium - a general survey.
1 barn = 10-28 m2, 1 MeV = 1.6 x 10-13 J

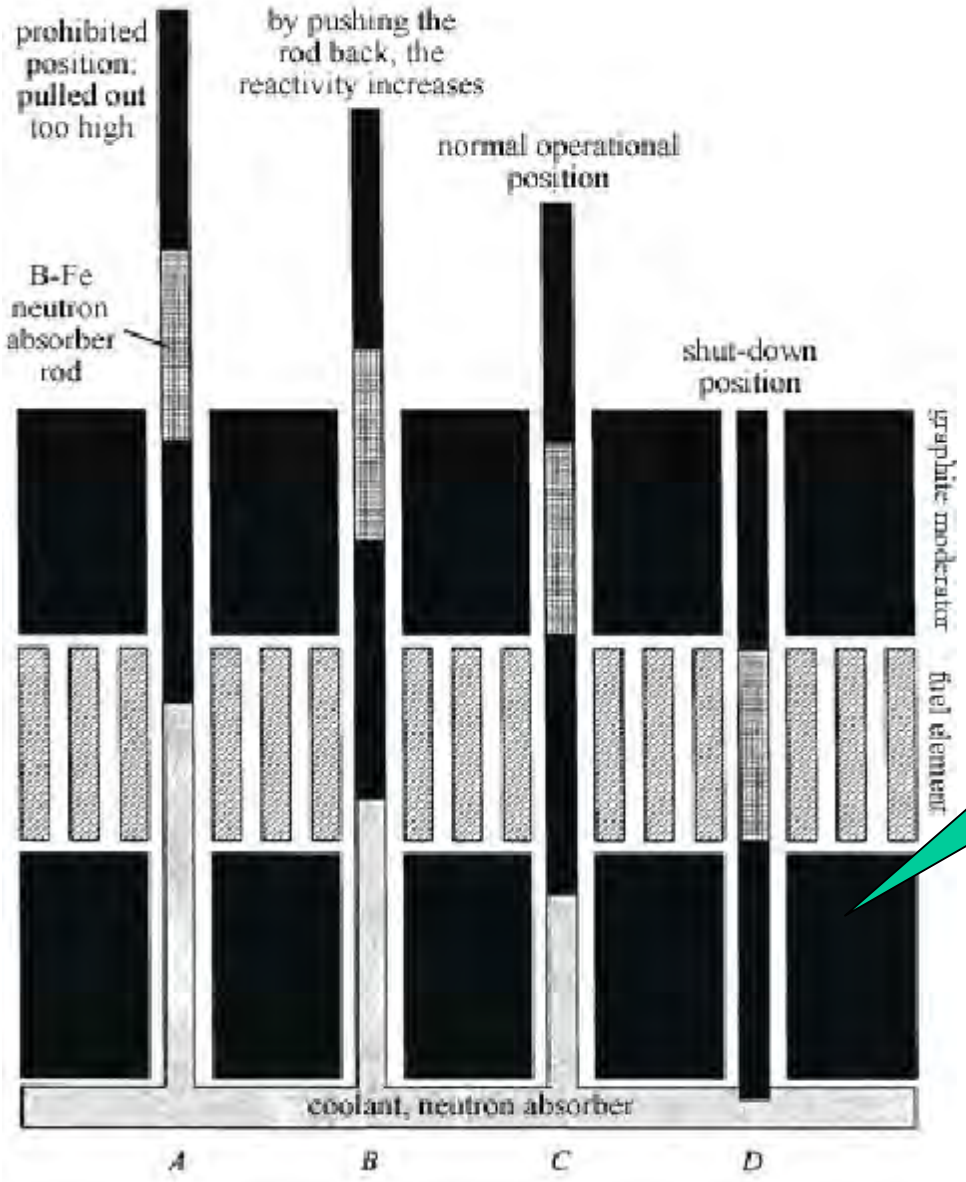

A
B
emission
scattering
absorption
1 cm


Steam
Heat exchanger
Water
Water Pump
Control rods
Calandria
Pressure tubes
Fuel rods
Heavy Water moderator
Heavy Water Pump
Concrete Shielding



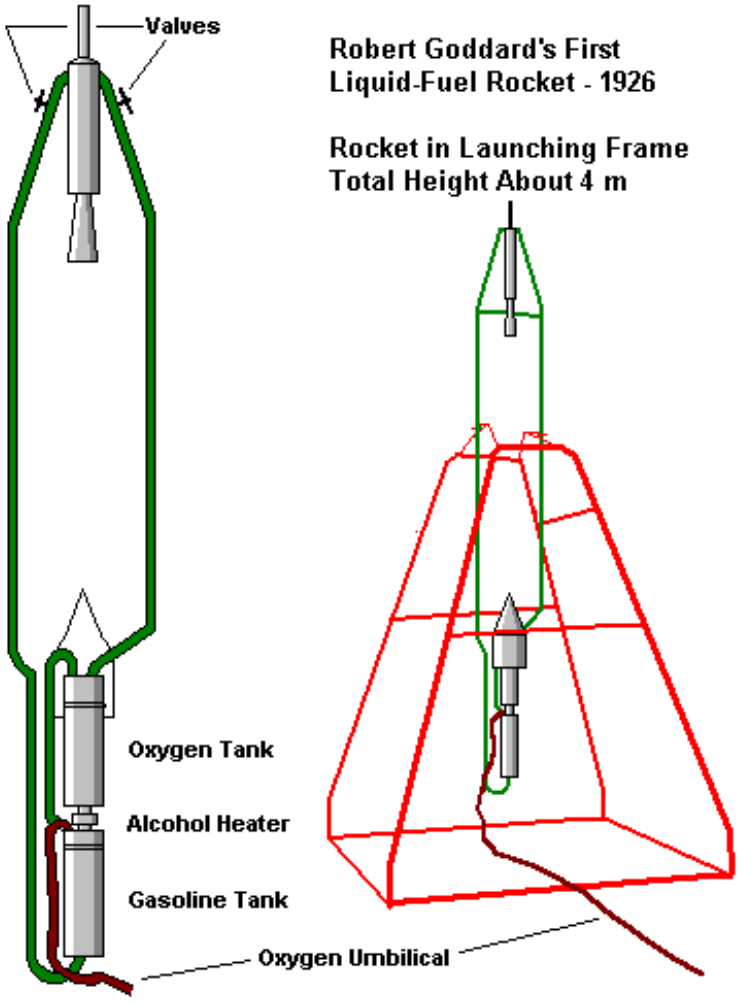

71.3m
Upper biological shield (UBS)
Pile of materials thrown from helicopters and possible location of part of the core
Core region (empty)
Spent fuel pool
LBS
6.0m
Location of fuel "Lava"
69.0m


Chernobyl



Solid graphite core continues to moderate neutrons as temperature increases (unlike heavy water where steam bubbles slow moderation)

No modern reactors use this design. Only a few remain in the former Soviet Union.



Robert Goddard's First
Liquid-Fuel Rocket - 1926

Rocket in Launching Frame
Total Height About 4 m

BELIEVES ROCKET CAN REACH MOON

Smithsonian Institution Tells of Prof. Goddard's Invention to Explore Upper Air.

MULTIPLE-CHARGE SYSTEM

Instruments Could Go Up 200 Miles, and Bigger Rocket Might Land on Satellite.

Special to The New York Times.

WASHINGTON, Jan. 11.—Announcement was authorized by the Smithsonian Institution tonight that Professor Robert H. Goddard of Clark College had invented and tested a new type of multiple-charge, high efficiency rocket of entirely new design for exploring the unknown regions of the upper air. The

TOPICS OF THE TIMES.

Still, to be filled with uneasy wonder and to express it will be safe enough, for after the rocket quits our air and really starts on its longer journey, its flight would be neither accelerated nor maintained by the explosion of the charges it then might have left. To claim that it would be is to deny a fundamental law of dynamics, and only Dr. EINSTEIN and his chosen dozen, so few and fit, are licensed to do that.

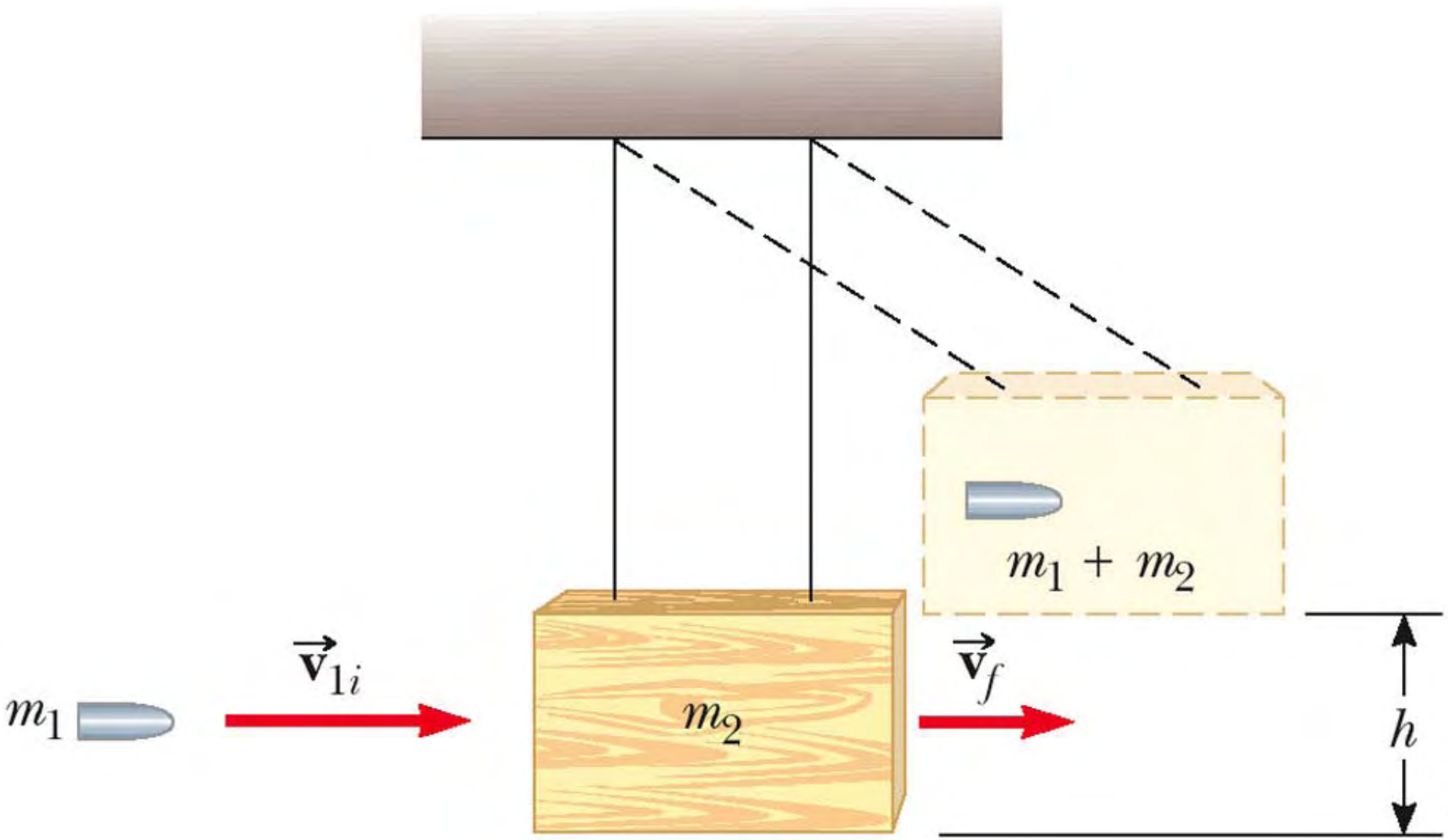
His Plan Is Not Original.

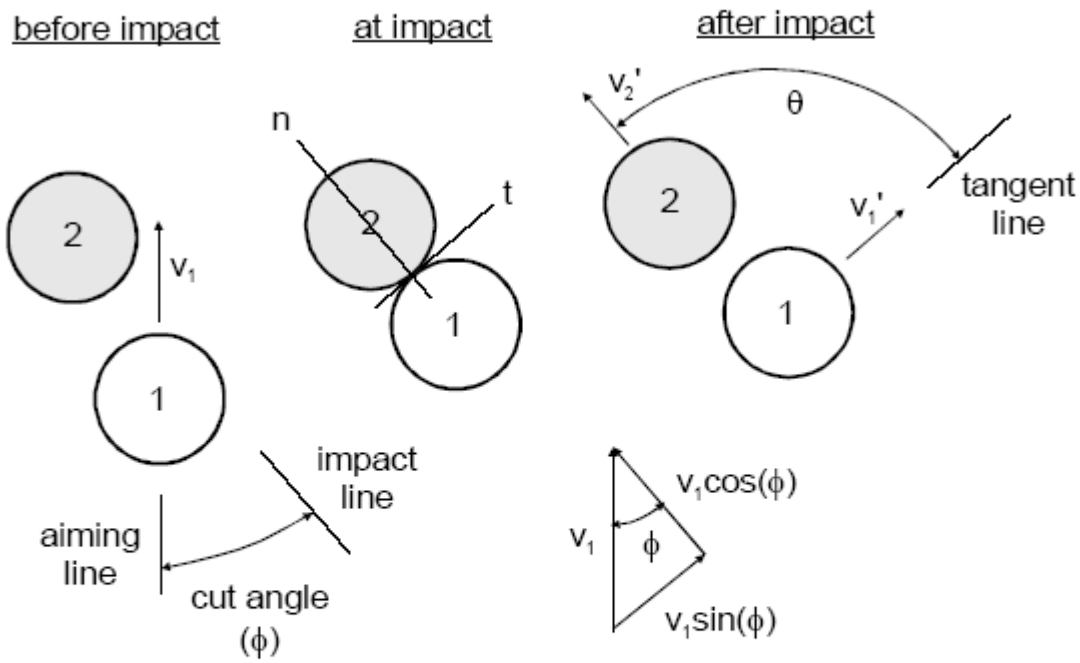
That Professor GODDARD, with his "chair" in Clark College and the countenancing of the Smithsonian Institution, does not know the relation of action to reaction, and of the need to have something better than a vacuum against which to react—to say that would be absurd. Of course he only seems to lack the knowledge ladled out daily in high schools.

("New York Times," 17 January, 1969)

Further investigation and experimentation have confirmed the findings of Isaac Newton in the 17th century, and it is now definitively established that a rocket can function in a vacuum as well as in an atmosphere. The Times regrets the error.

Ballistic Pendulum



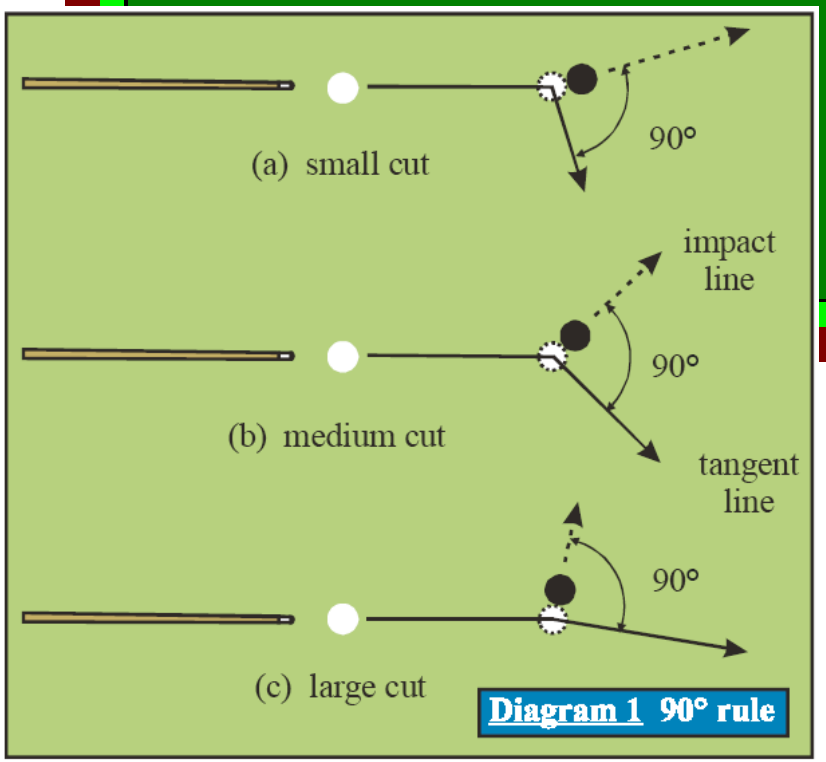


Assumptions:

- the coefficient of friction between the balls is negligible
- the collision is perfectly elastic (the coefficient of restitution is 1)
- both balls have the same mass
- ball 2 is stationary initially

Is this a scratch shot?

(White cue ball goes in pocket even if yellow target ball does too.)



http://www.engr.colostate.edu/~dga/pool/

proton-proton collisions in a hydrogen bubble chamber