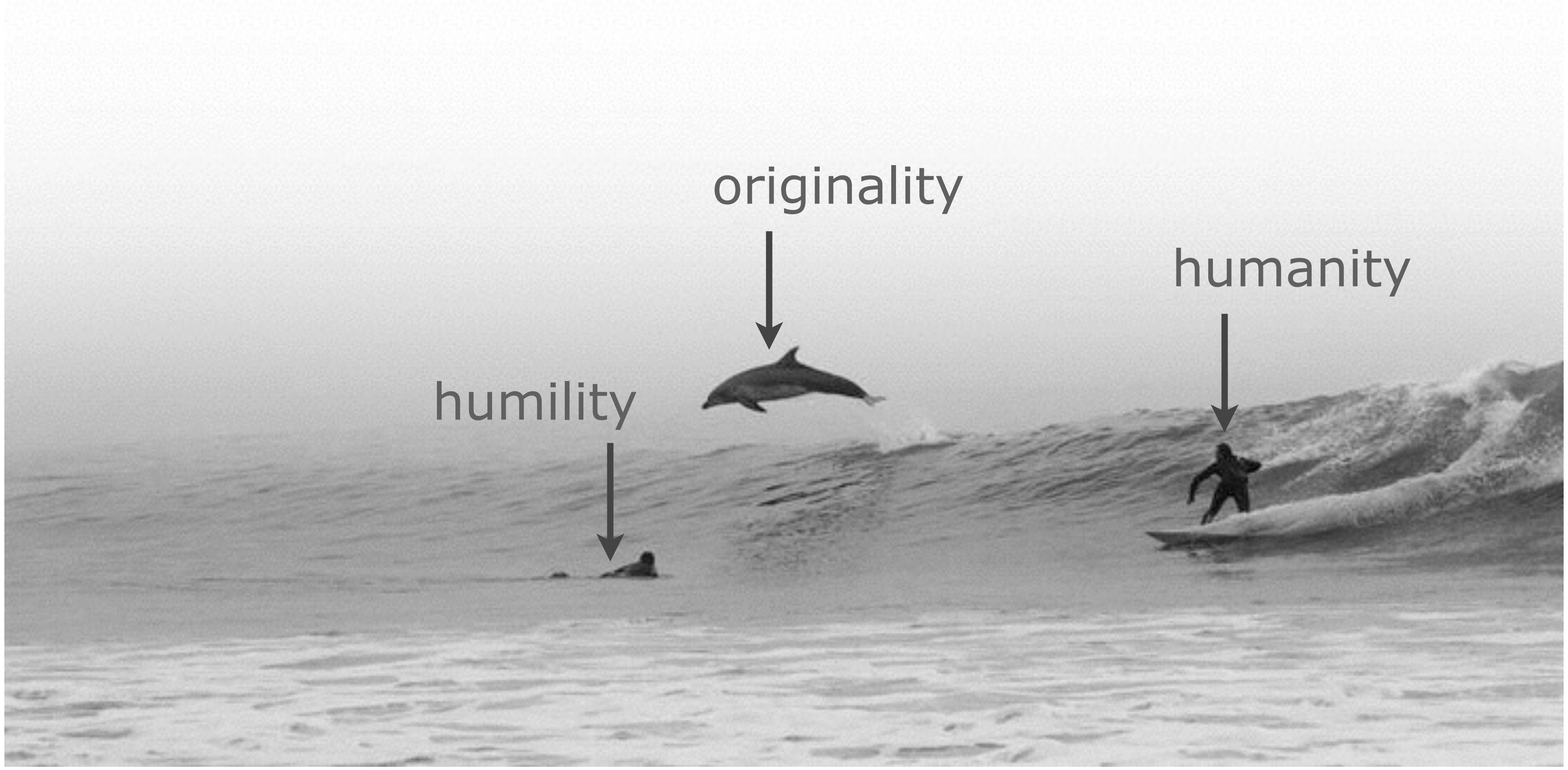
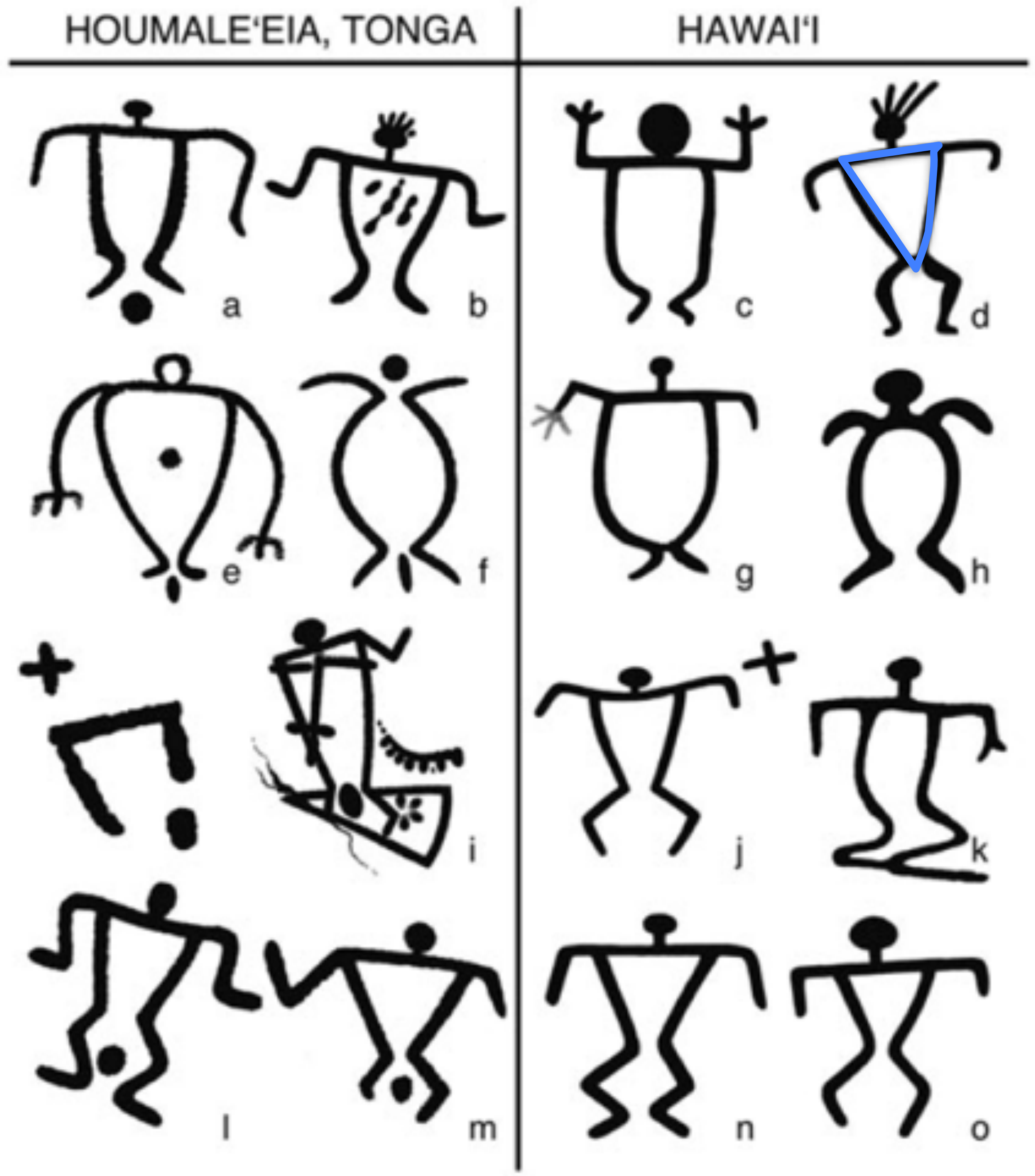
physics of surfing

Eline Dehandschoewercker
Marc de Gennes



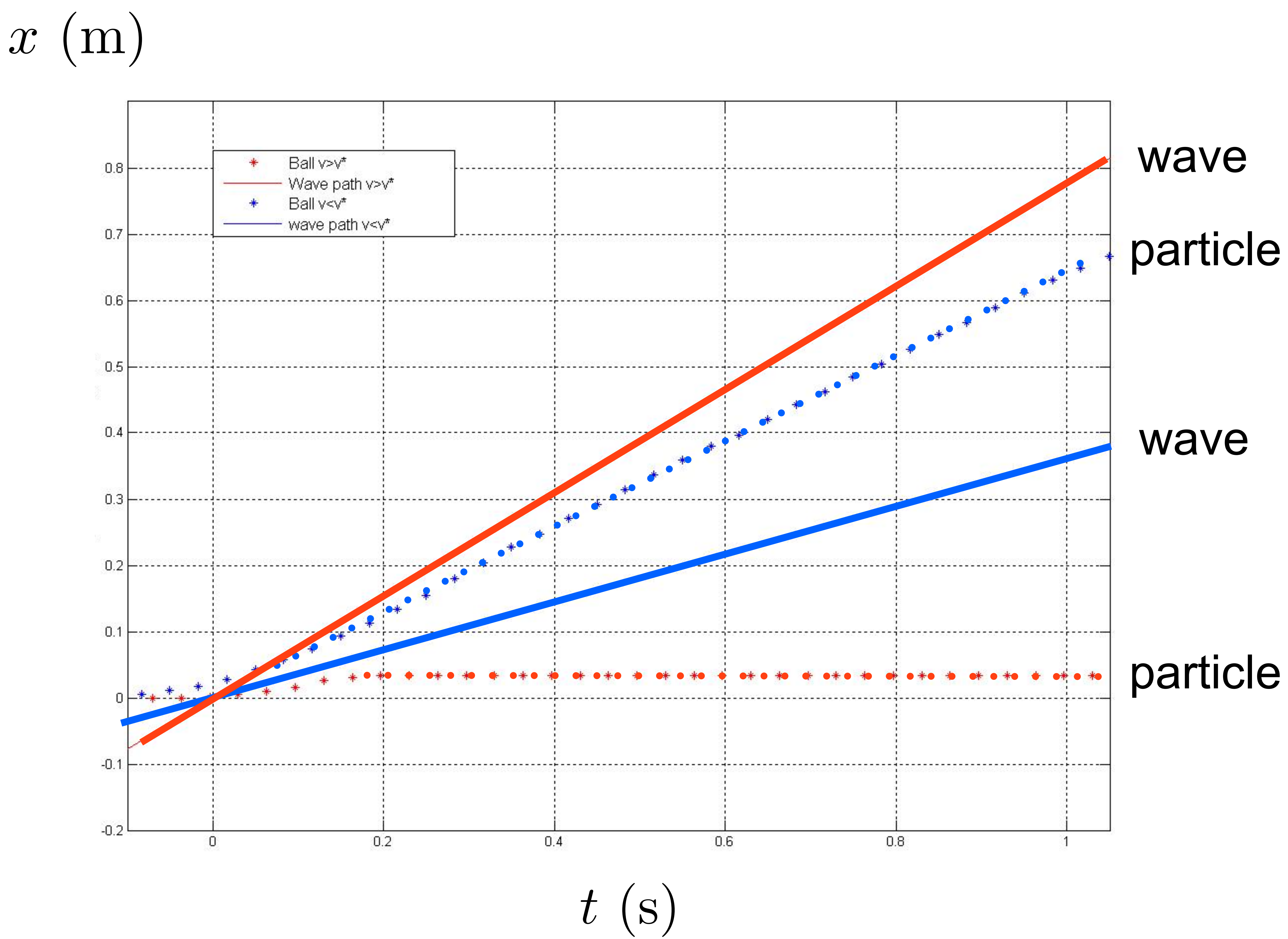


TRIANGULAR MEN ON ONE VERY LONG VOYAGE: THE CONTEXT AND IMPLICATIONS OF A HAWAIIAN-STYLE PETROGLYPH SITE IN THE POLYNESIAN KINGDOM OF TONGA

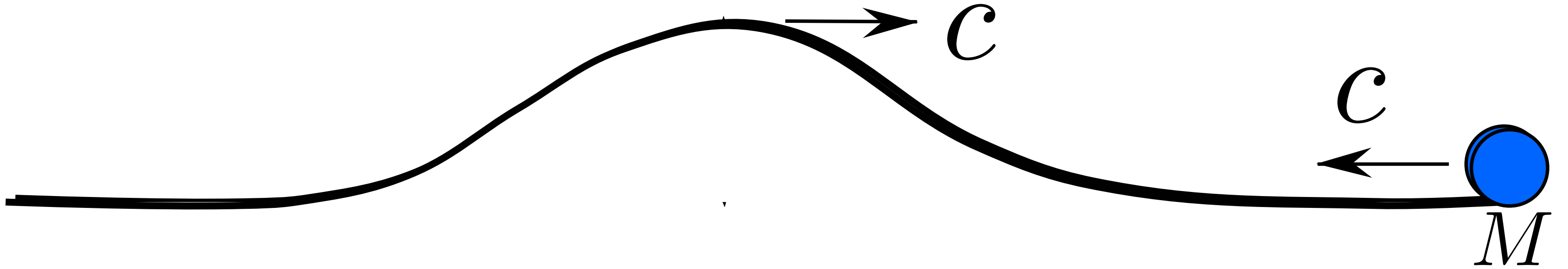
SHANE EGAN
Kanokupolu, Tongatapu, Kingdom of Tonga

DAVID V. BURLEY
Simon Fraser University


7NEWS
JOSH ADSETT Reporting
Seaway Thrills
7 NEWS
SOUTHPORT SEAWAY



x (m)
Ball v>v*
Wave path v>v*
Ball v<v*
wave path v<v*
wave
particle
wave
particle
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
-0.1
-0.2
0
0.2
0.4
0.6
0.8
1
t (s)



$$\frac{1}{2}Mc^2 = MgH$$

$$H = \frac{c^2}{2g} \overset{?}{<} A$$

$$\boxed{A > \frac{c^2}{2g}}$$

$$c^2 = \frac{g}{k}$$

$$\Bigg\} \quad Ak > \frac{1}{2}$$

Annu. Rev. Fluid Mech. 2004. 36:1–28
doi: 10.1146/annurev.fluid.36.050802.122118

THE ORIGINS OF WATER WAVE THEORY

Alex D.D. Craik

1. WATER WAVES BEFORE 1800: NEWTON, LAPLACE, LAGRANGE

Isaac Newton was the first to attempt a theory of water waves. In *Book II, Prop. XLV* of *Principia* (1687), he proposed a dubious analogy with oscillations in a U-tube,

Si de l'eau descend et monte alternativement dans les branches KL, MN *d'un canal ; et qu'on ait un pendule dont la longueur entre le point de suspension et le centre d'oscillation soit égale à la moitié de la longueur de la colonne d'eau qui est dans le canal : je dis que l'eau montera et descendra dans ce canal dans les mêmes temps dans lesquels ce pendule oscillera.*

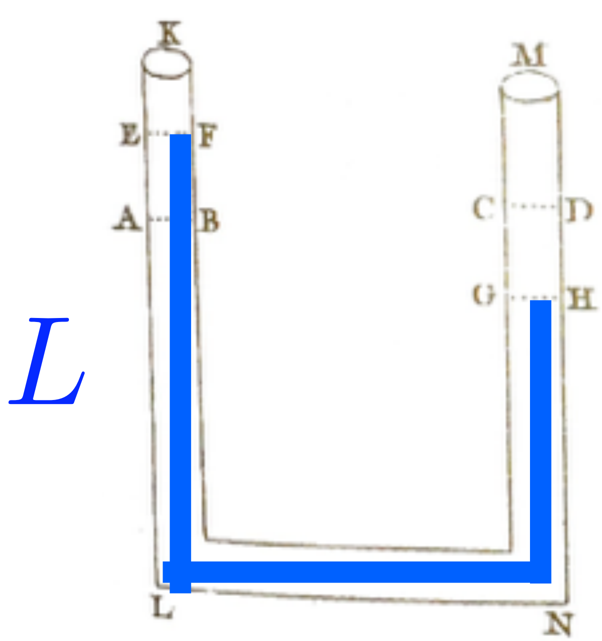


FIG. 51.

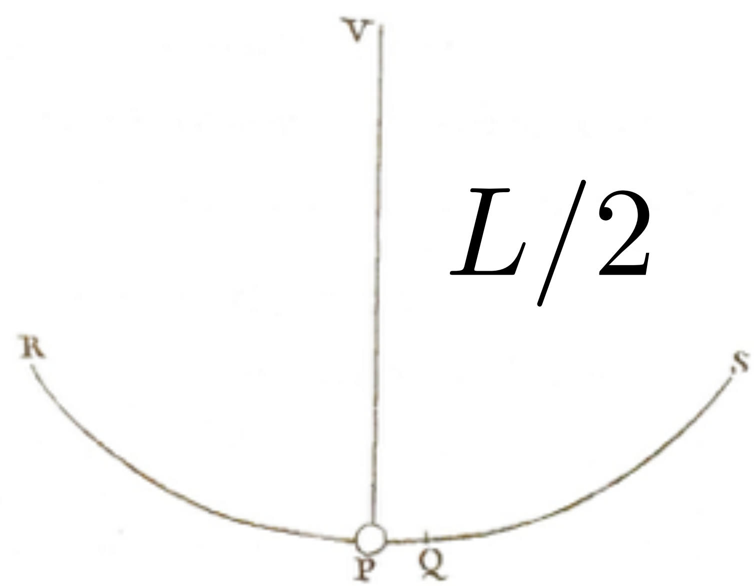


FIG. 52.

$$\omega^2 = \frac{2g}{L}$$

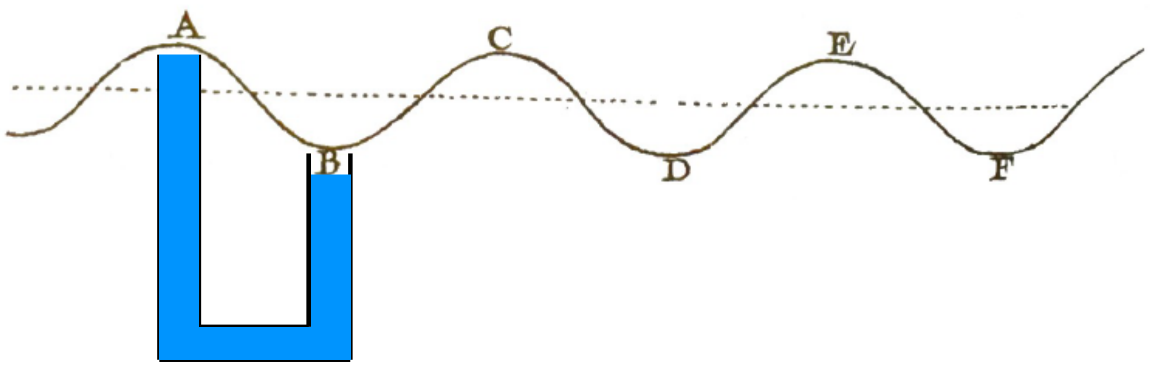
PROPOSITION XLV – THÉORÈME XXXVI

La vitesse des ondes est en raison sous-doublée de leur largeur.

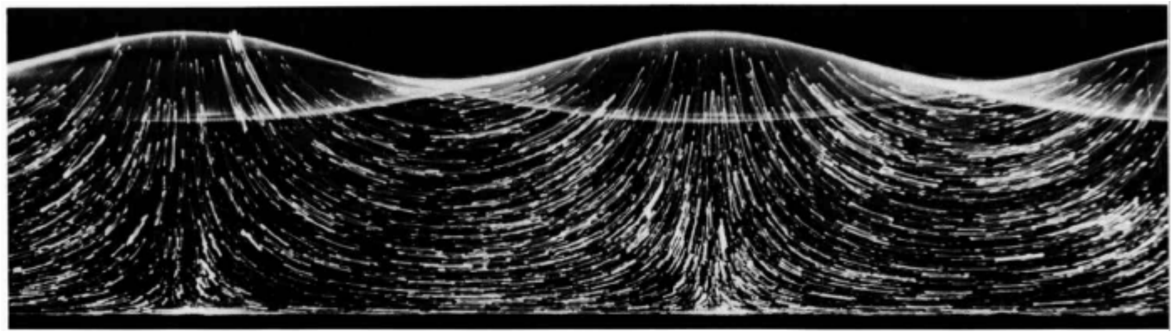
C'est ce qui suit de la construction de la Proposition suivante.

PROPOSITION XLVI – PROBLÈME X

Trouver la vitesse des ondes.

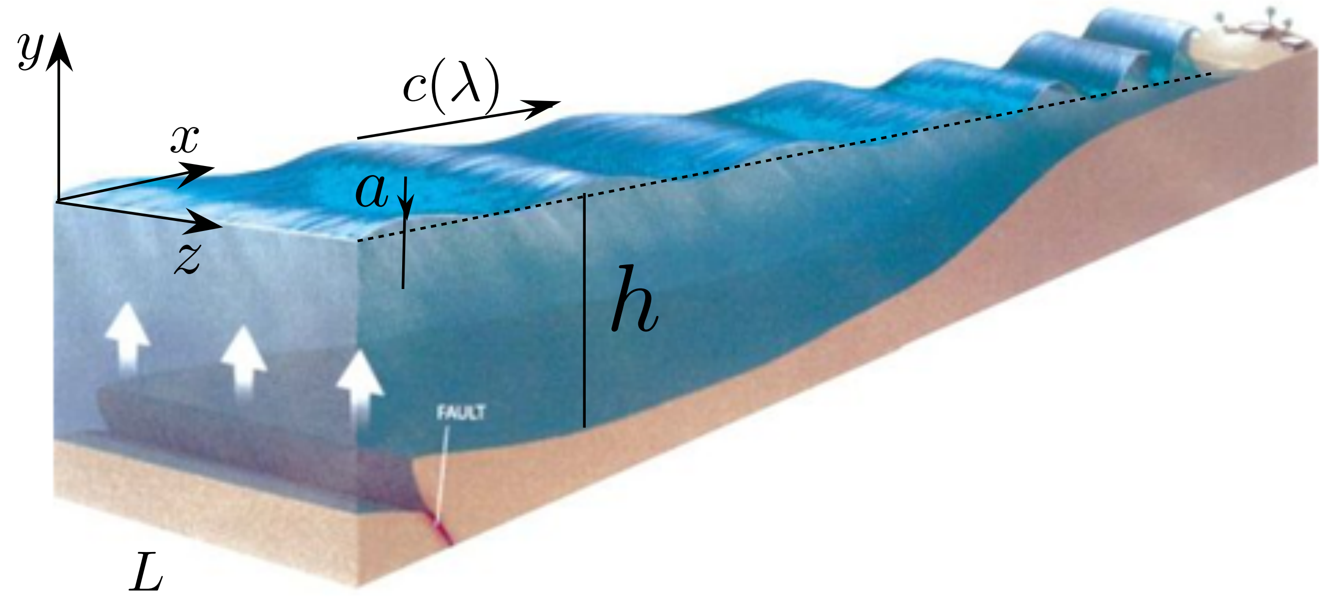


$\lambda/2$



$$\left.\begin{aligned} \omega^2 &= \frac{2g}{L} \\ L &\sim \lambda \end{aligned}\right\}$$

$$\boxed{\omega^2 \sim g/\lambda}$$



$$\langle K \rangle = \frac{\pi}{2}\rho c^2 a^2 L.\frac{1}{\tanh(kh)}$$

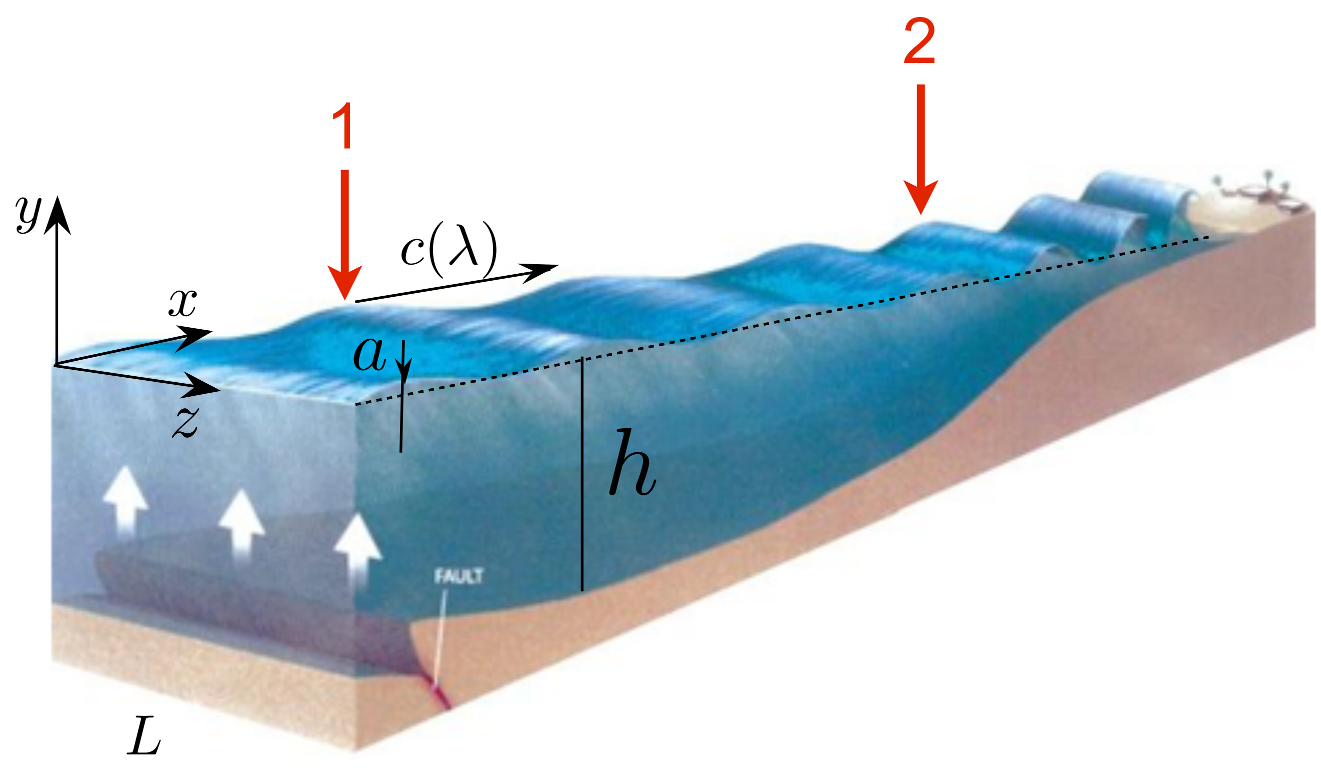
$$\langle U \rangle = \frac{\pi}{2}\rho g L \frac{a^2}{k}$$

$$c^2 = \frac{g}{k}\tanh(kh)$$

$$\langle E \rangle = \langle K \rangle + \langle U \rangle = \frac{1}{2}\rho g L a^2 \lambda$$

$$a^2 \lambda = Cte$$

Shoaling



law of waves: « the period is conserved ! »

$$\frac{\Delta t}{[\lambda/c(\lambda)]_1} = \frac{\Delta t}{[\lambda/c(\lambda)]_2}$$

$$\lambda/c(\lambda) = Cte$$

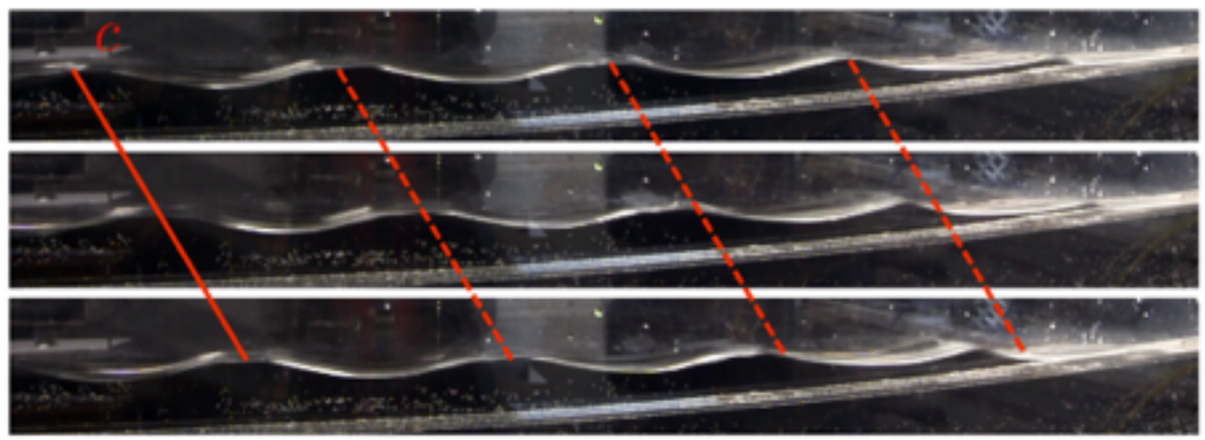
deep water: $\lambda = Cte$

shallow water: $\lambda \sim \sqrt{h}$

$$a^2\lambda = Cte$$

$$a \sim h^{-1/4}$$

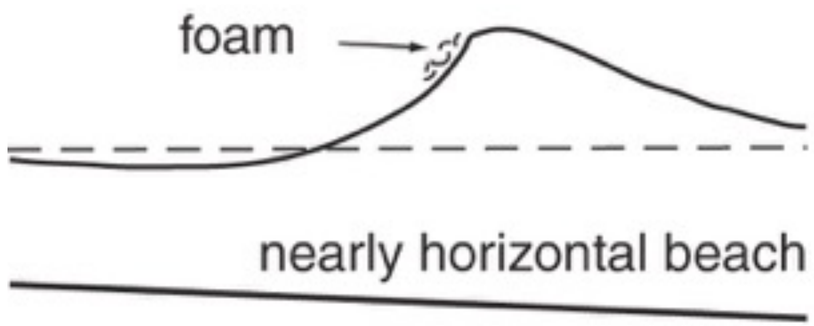
$$a/\lambda \sim 1/h^{3/4}$$


c

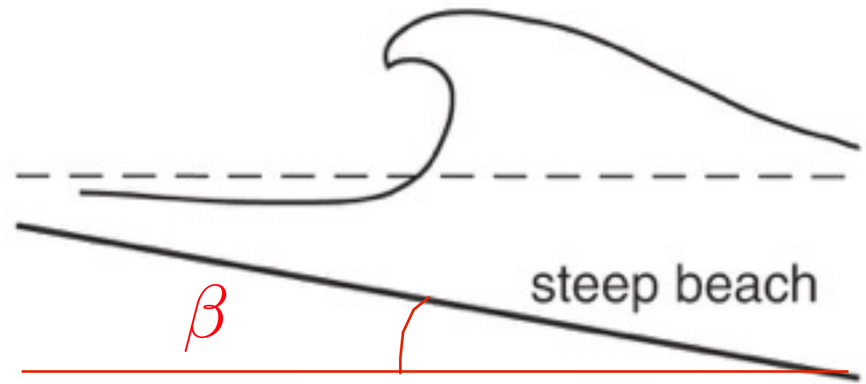
CLASSIFICATION OF WAVES

«Nearshore Dynamics and Coastal Processes: Theory, Measurement, and Predictive Models» Kiyoshi Horikawa (1988)

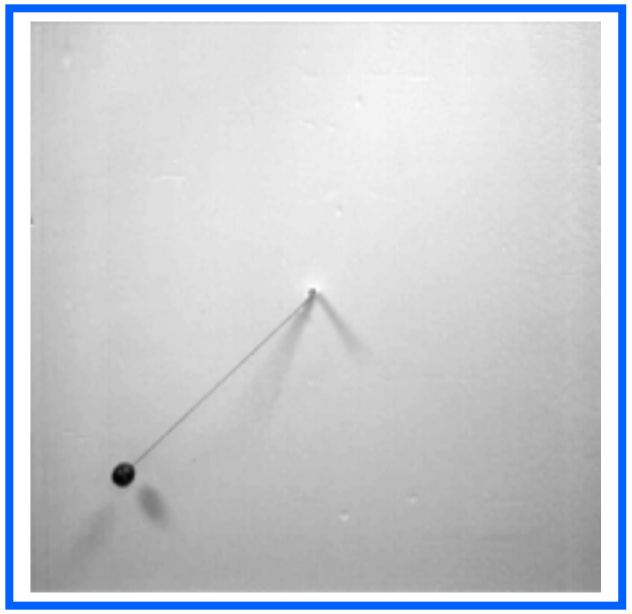
I. Spilling breakers

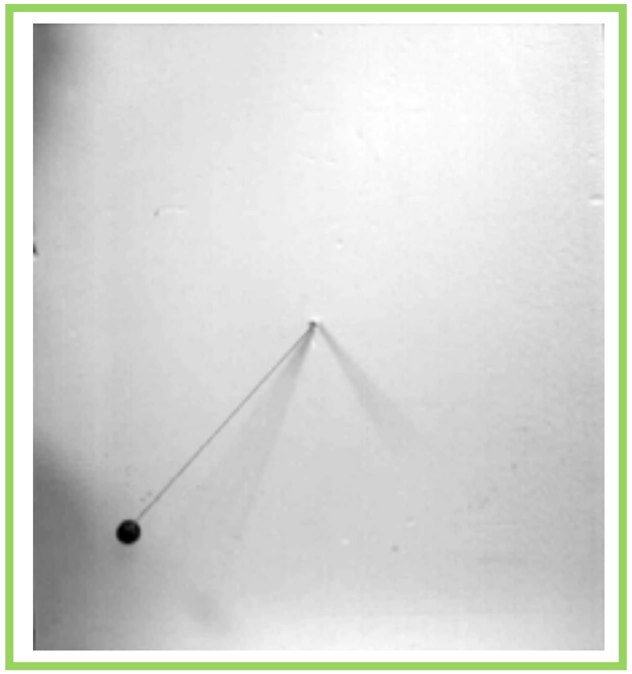


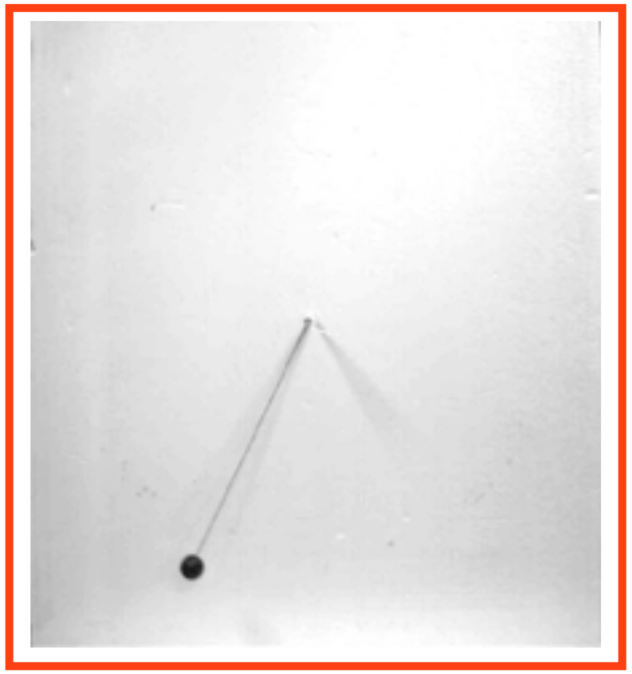
II. Plunging breakers

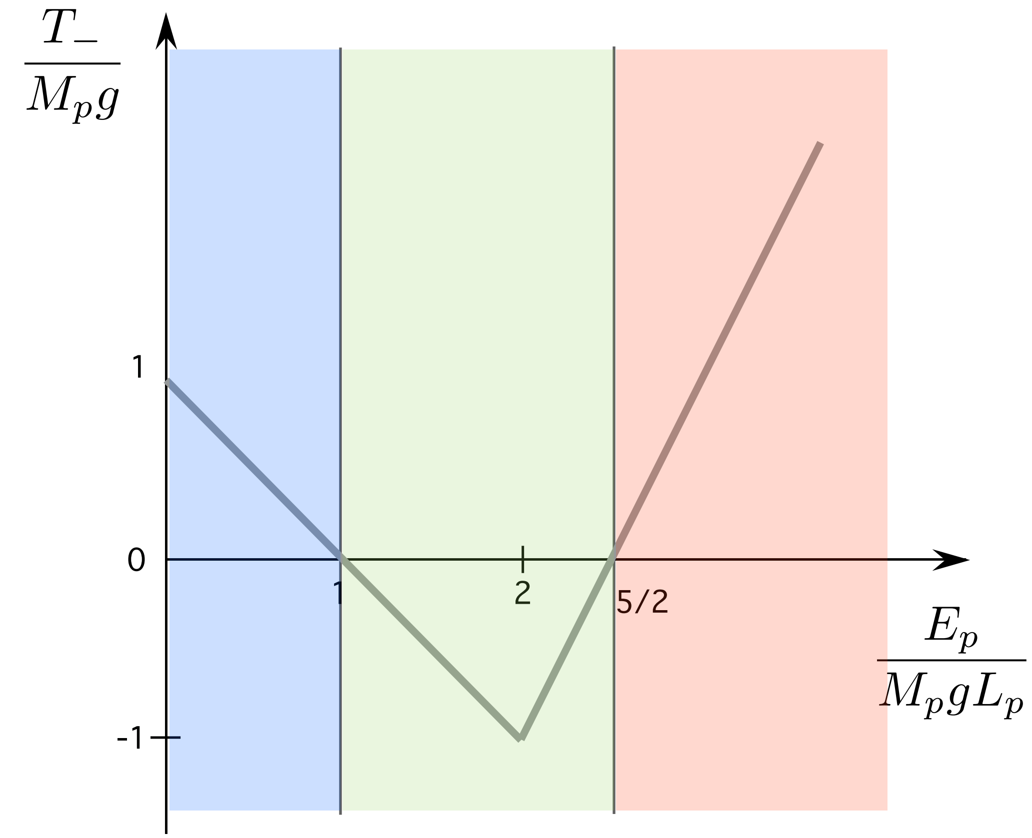


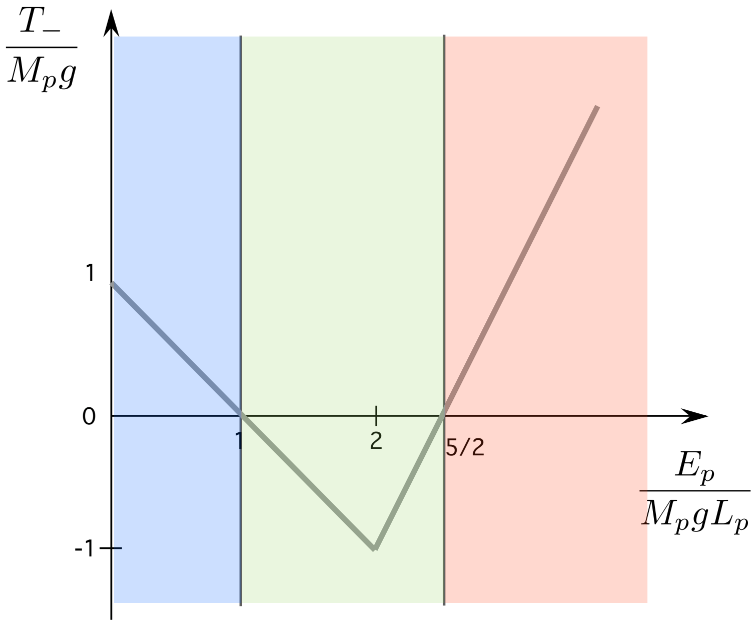
pendulum analogy





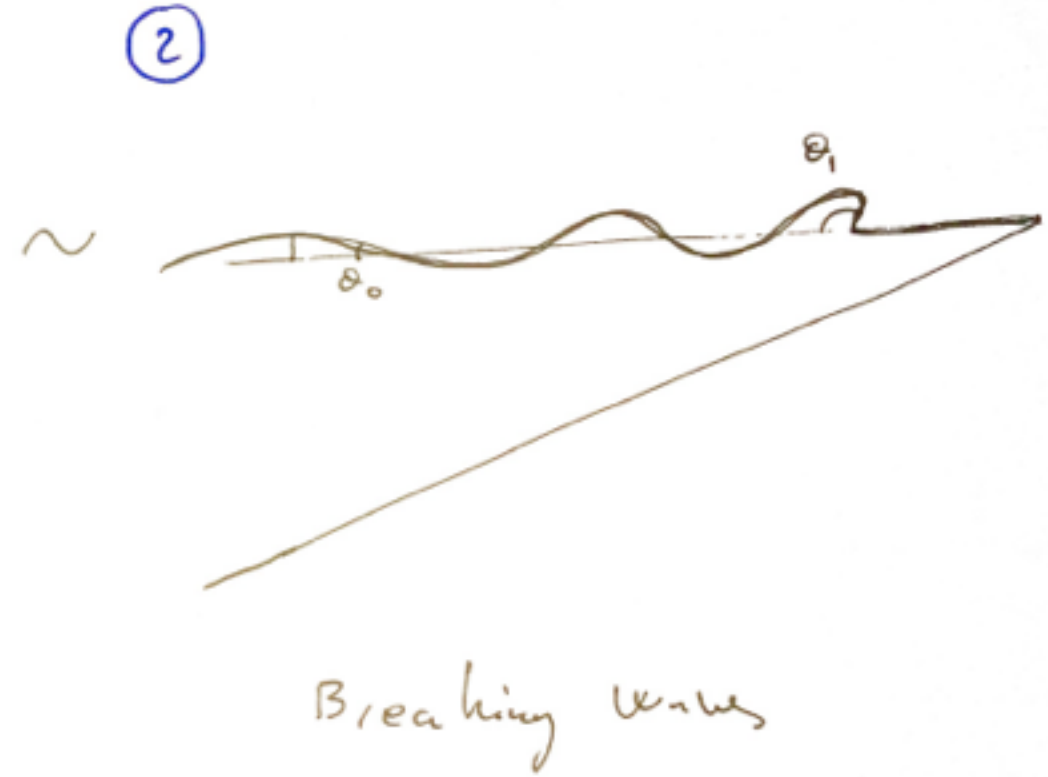




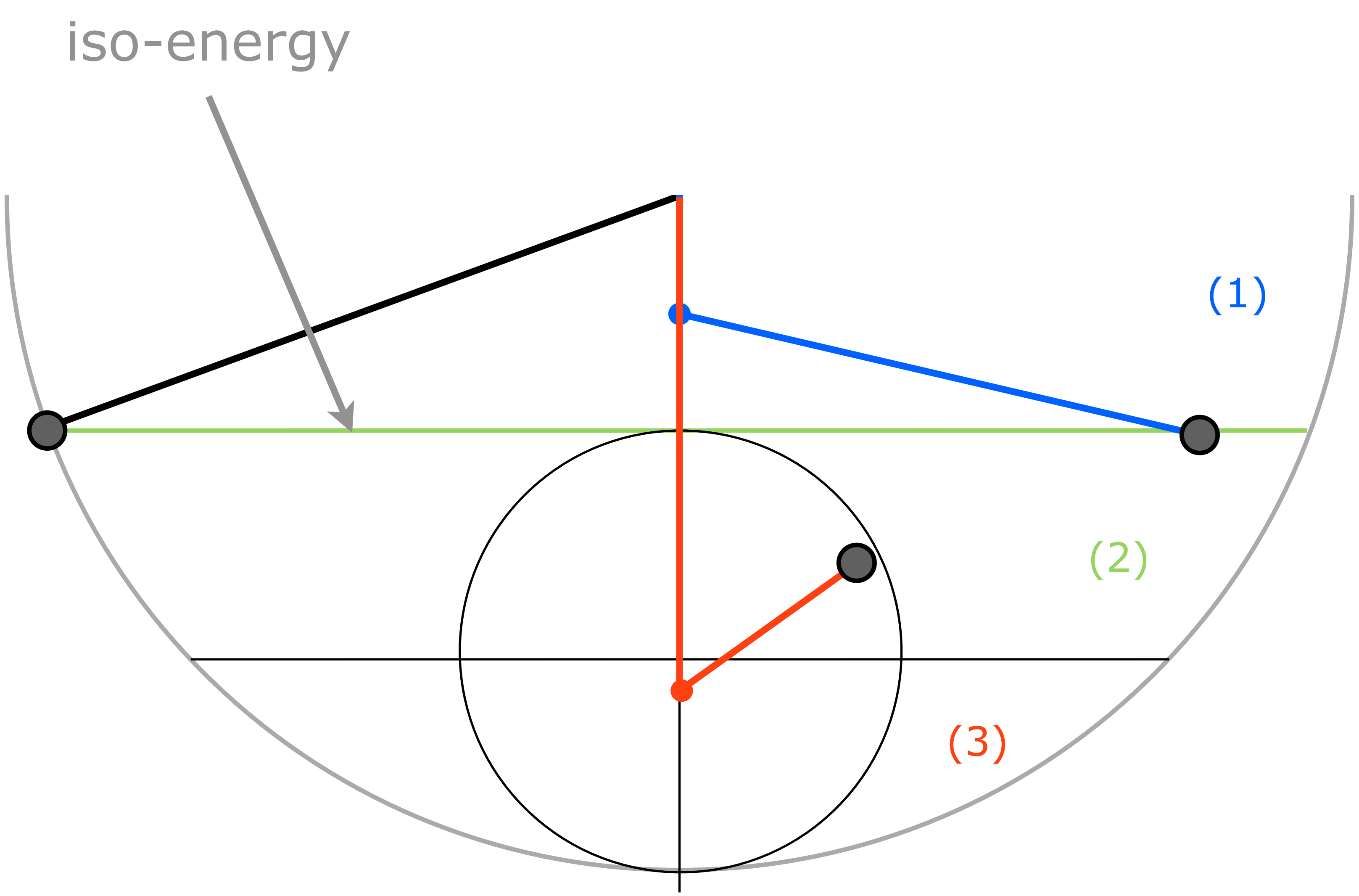


$\frac{T_-}{M_p g}$
1
0
-1
1
2
5/2
$\frac{E_p}{M_p g L_p}$

1
θ_0
θ_1
Pendule

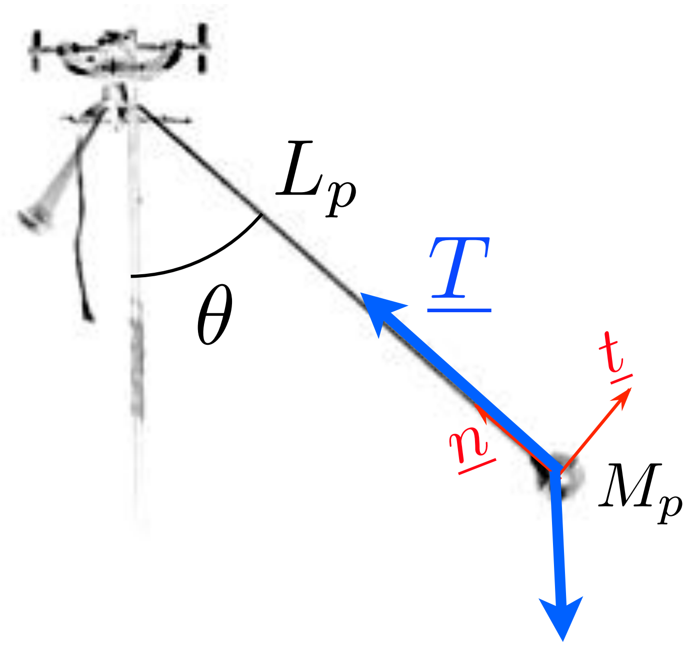


2
θ_1
θ_0
Breaking waves



iso-energy
(1)
(2)
(3)

pendulum analogy



NATURE December 5, 1953 VOL. 172

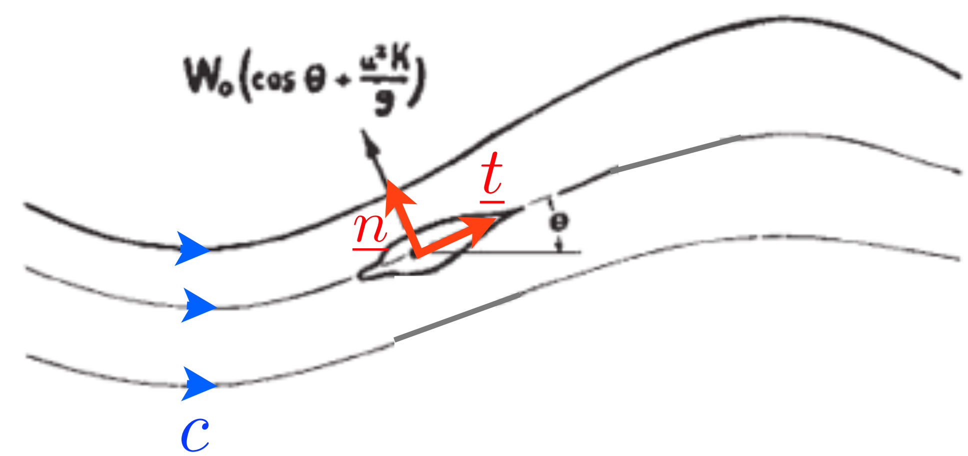


Fig. 1. Dolphin in a wave

$$\underline{T} = M_p \frac{d\underline{U}}{dt} - M_p \underline{g}$$

$$-\underline{\mathrm{grad}}\, p = \rho \frac{D\underline{U}}{Dt} - \rho \underline{g} \qquad \underline{U} = c\underline{t}$$

$$T = M_p g \left(\cos\theta + \frac{U^2}{g L_p} \right)$$

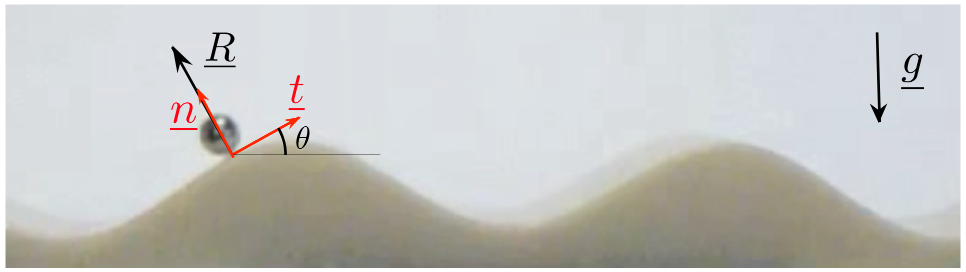
$$-\underline{\mathrm{grad}}\, p = \rho g \left(\cos\theta + \frac{c^2}{g} \frac{d\theta}{ds} \right) \underline{n}$$

transition

$$\frac{c^2}{g} \frac{d\theta}{ds} > 1$$

$$\frac{1}{k} a k^2 = ak > 1$$

analogie with rolling spheres



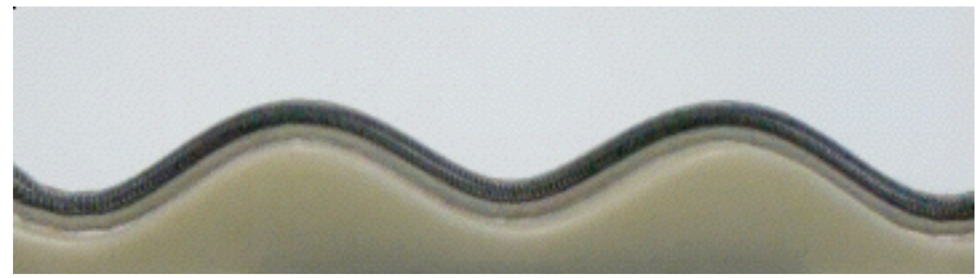
$$M\frac{d\underline{U}}{dt} = \underline{R} + M\underline{g}$$

$$\underline{R} = M\frac{d\underline{U}}{dt} - M\underline{g}$$

$$R = Mg\left(\cos\theta + \frac{U^2}{g}\frac{d\theta}{ds}\right)$$

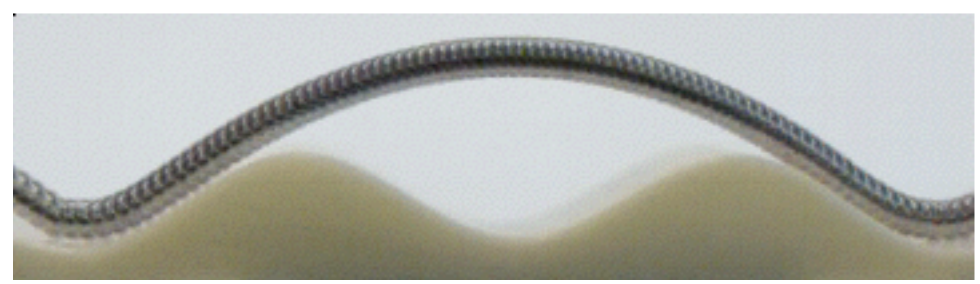
$$-\underline{\mathrm{grad}}\, p = \rho g\left(\cos\theta + \frac{c^2}{g}\frac{d\theta}{ds}\right)\underline{n}$$

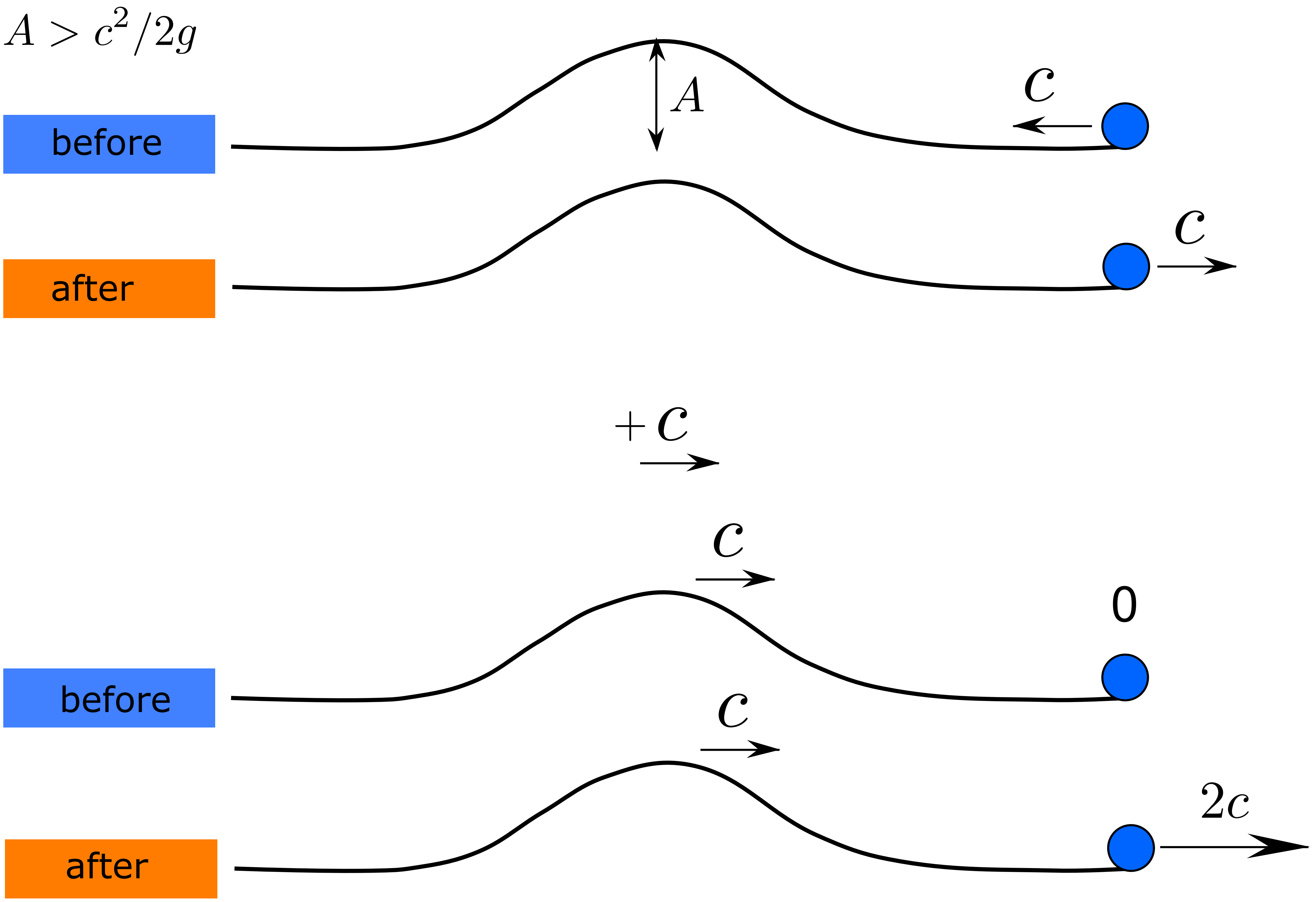
analogie with rolling spheres

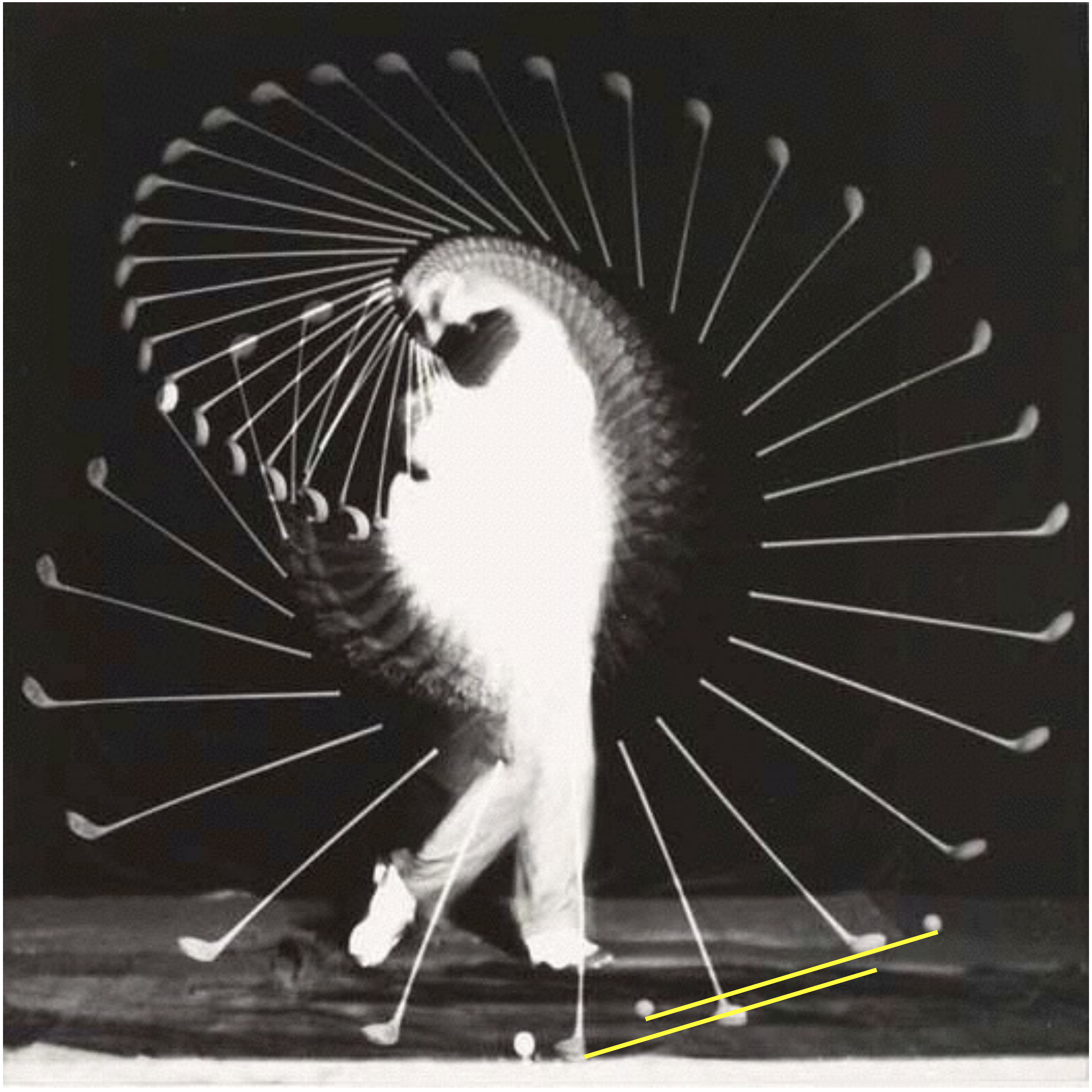



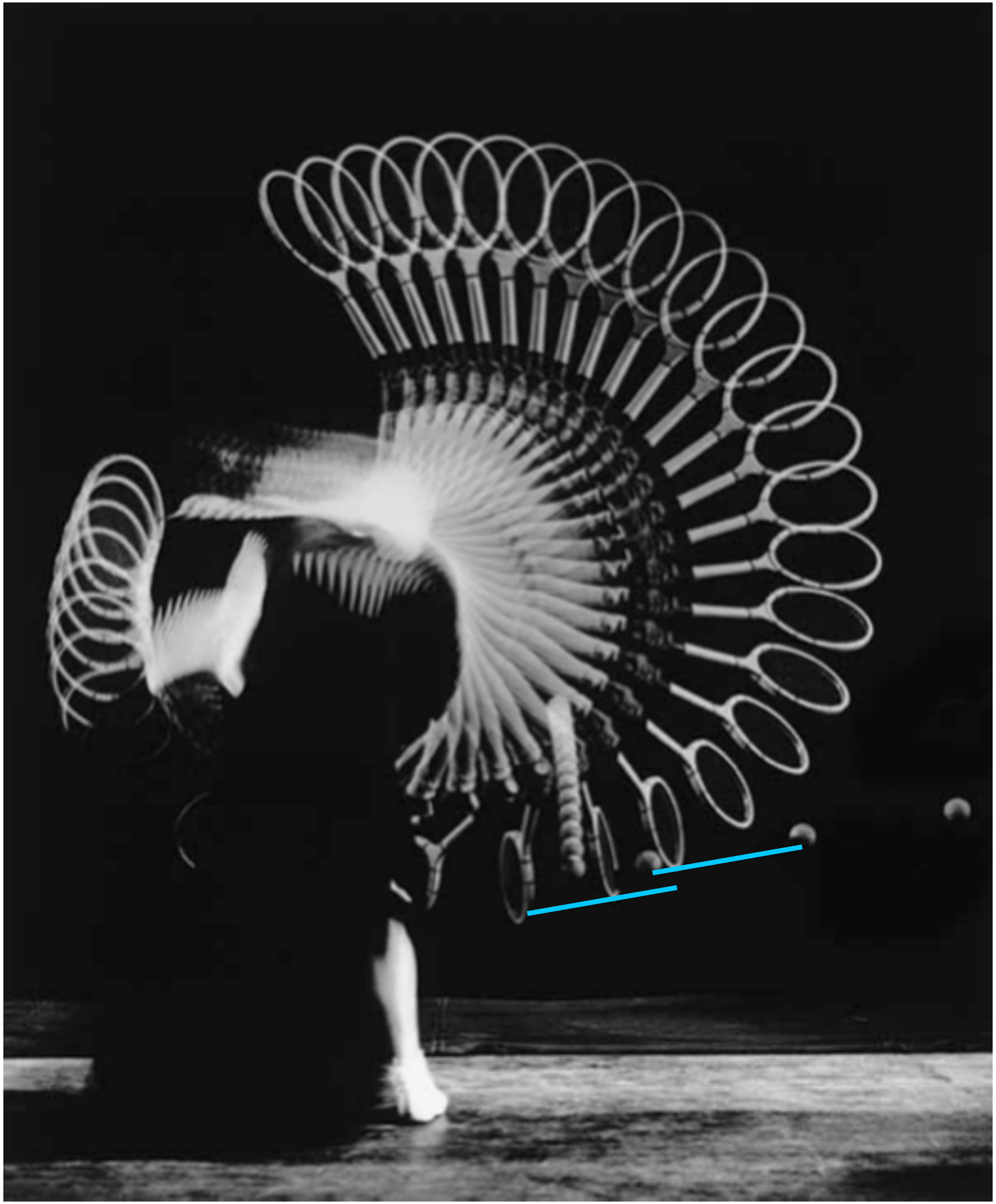


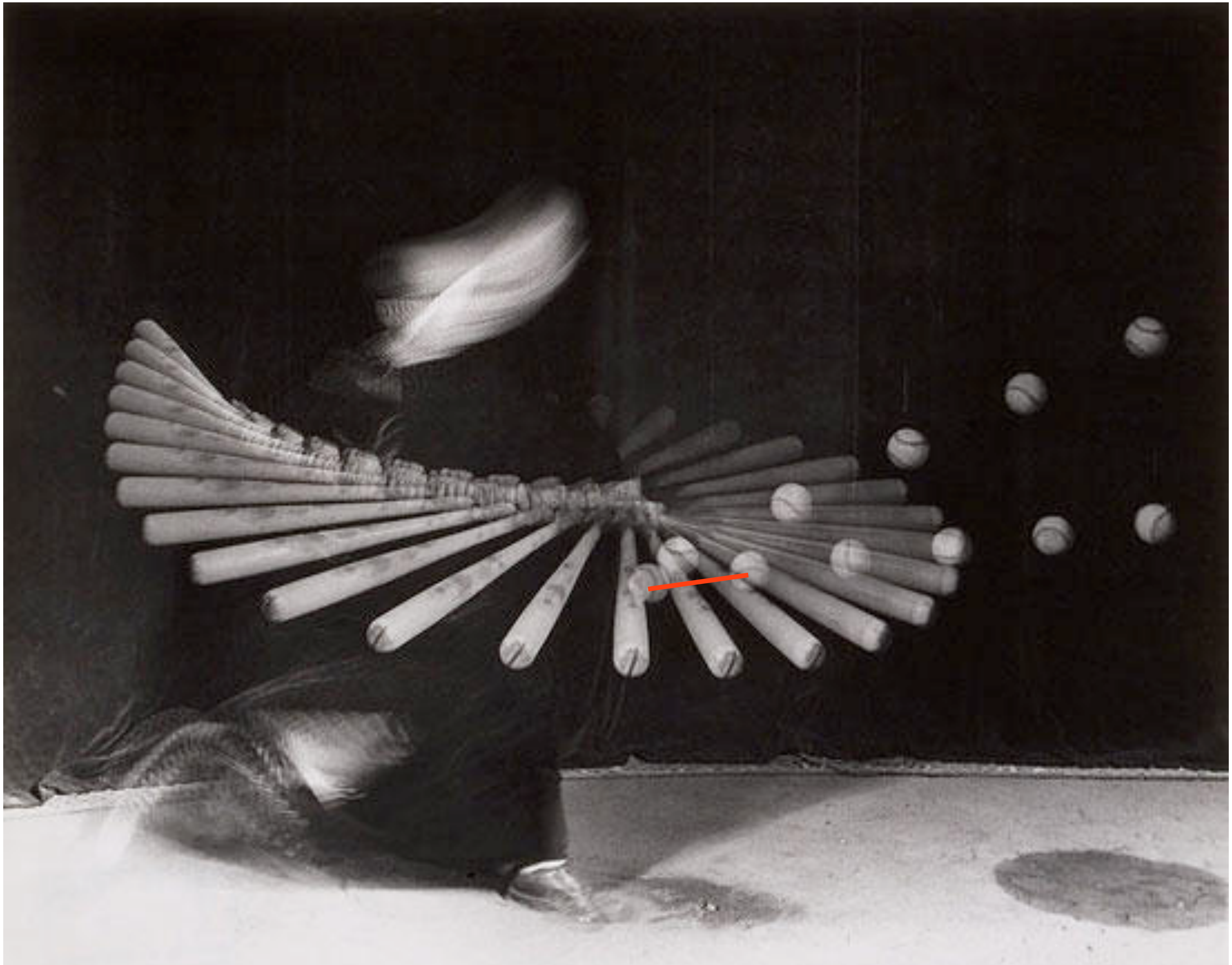


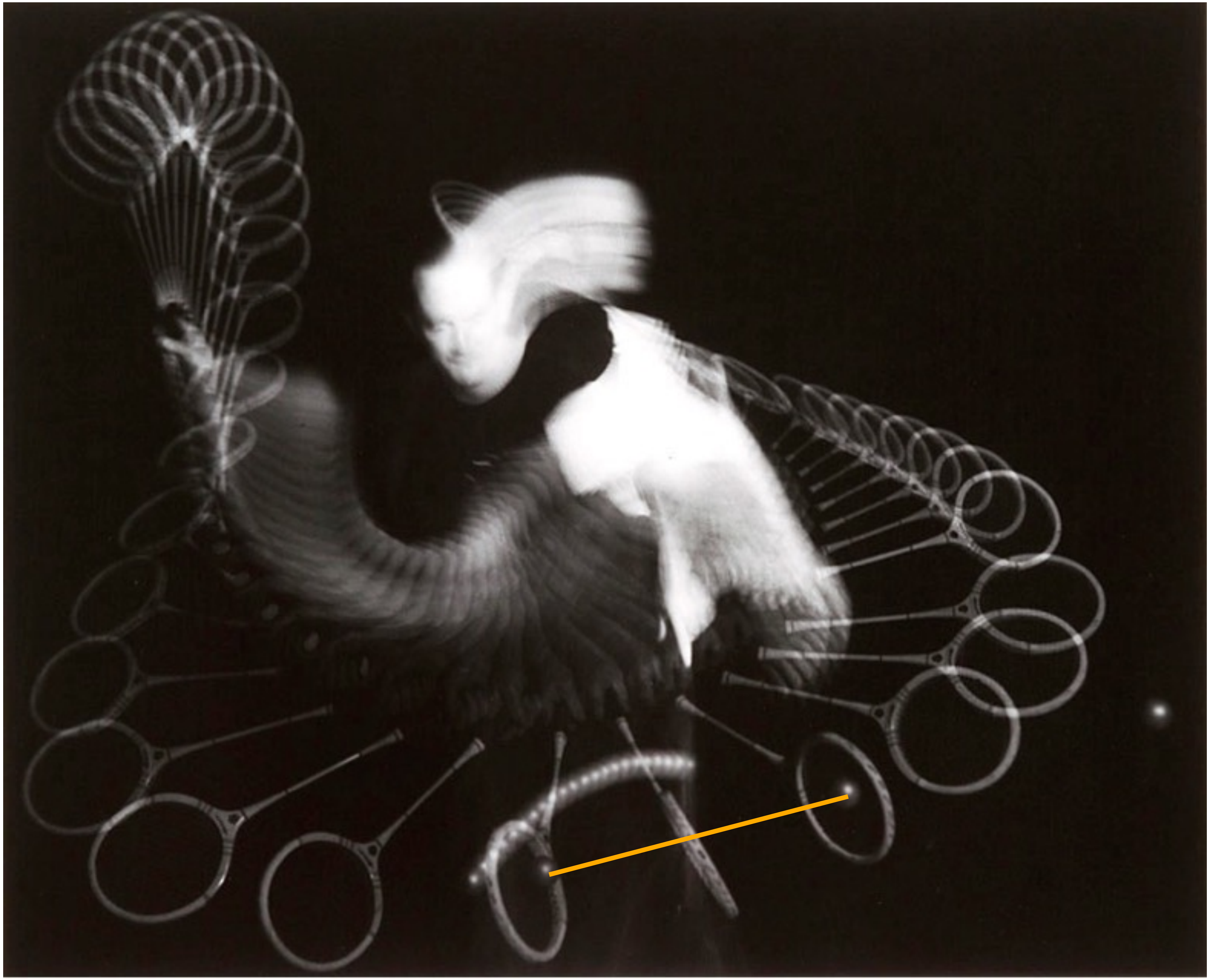


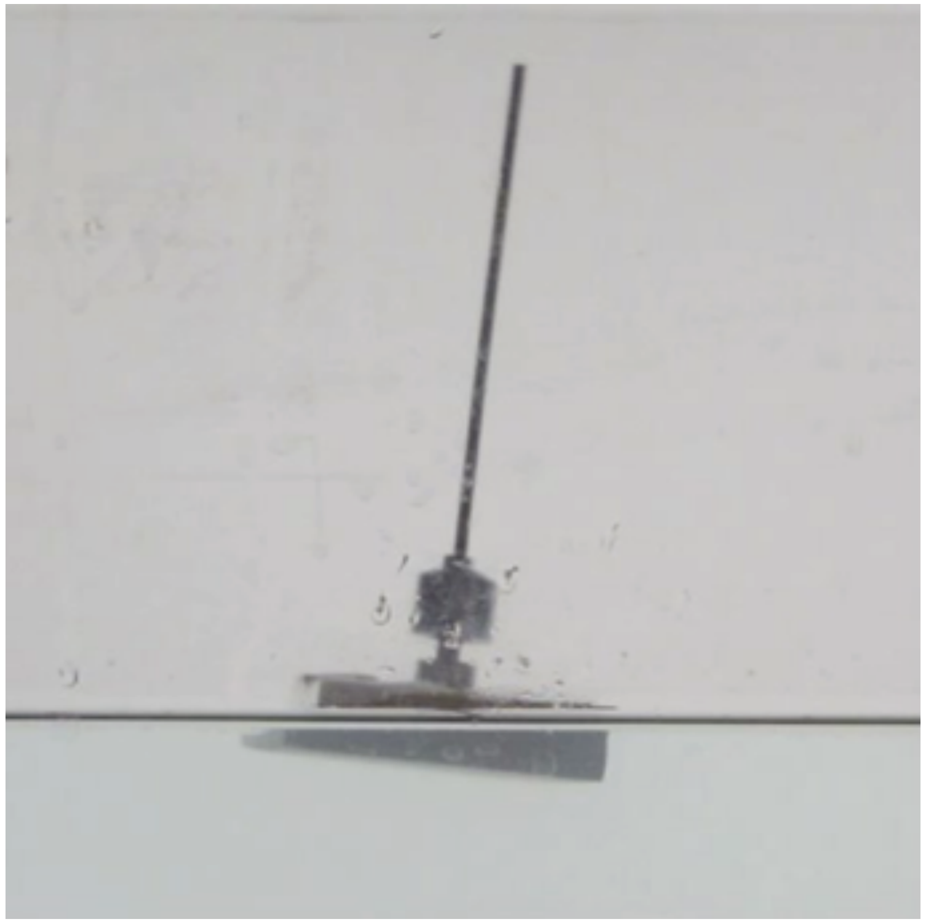
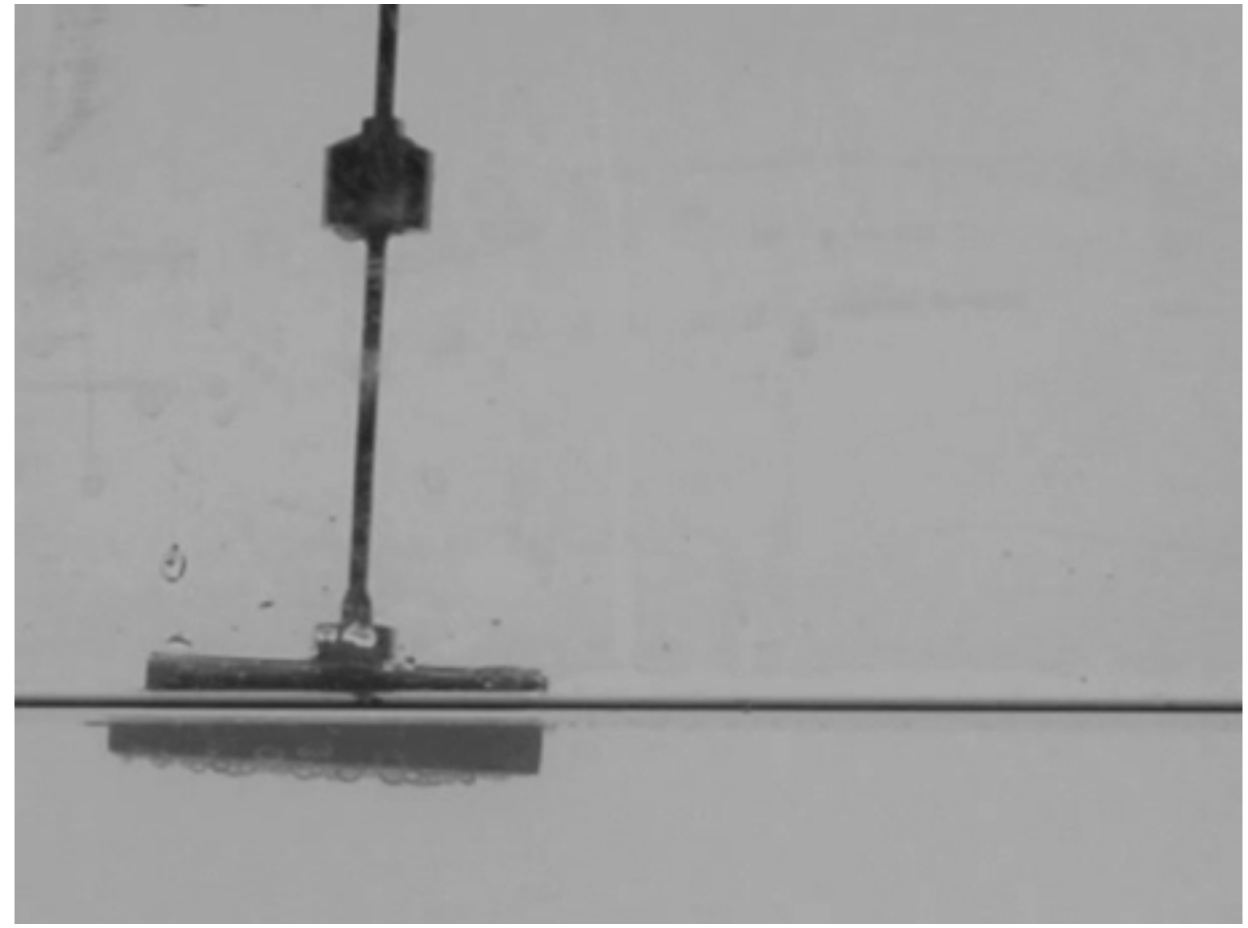


$A > c^2/2g$
before
A
c
after
c
$+c$
c
before
0
c
after
$2c$









Sports Physics 2016

8, 9 & **10** june 2016

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