

# Sports and Physics

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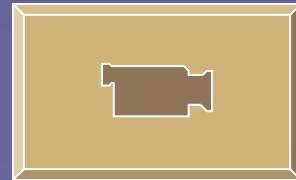
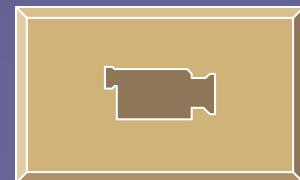
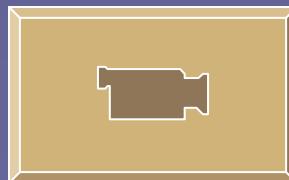
# Basketball

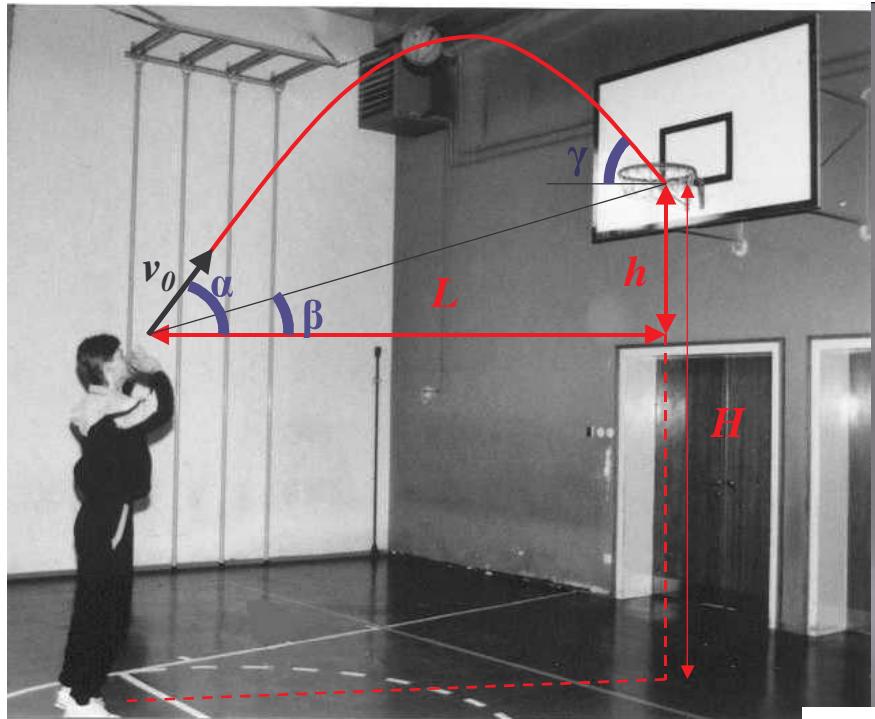


Video



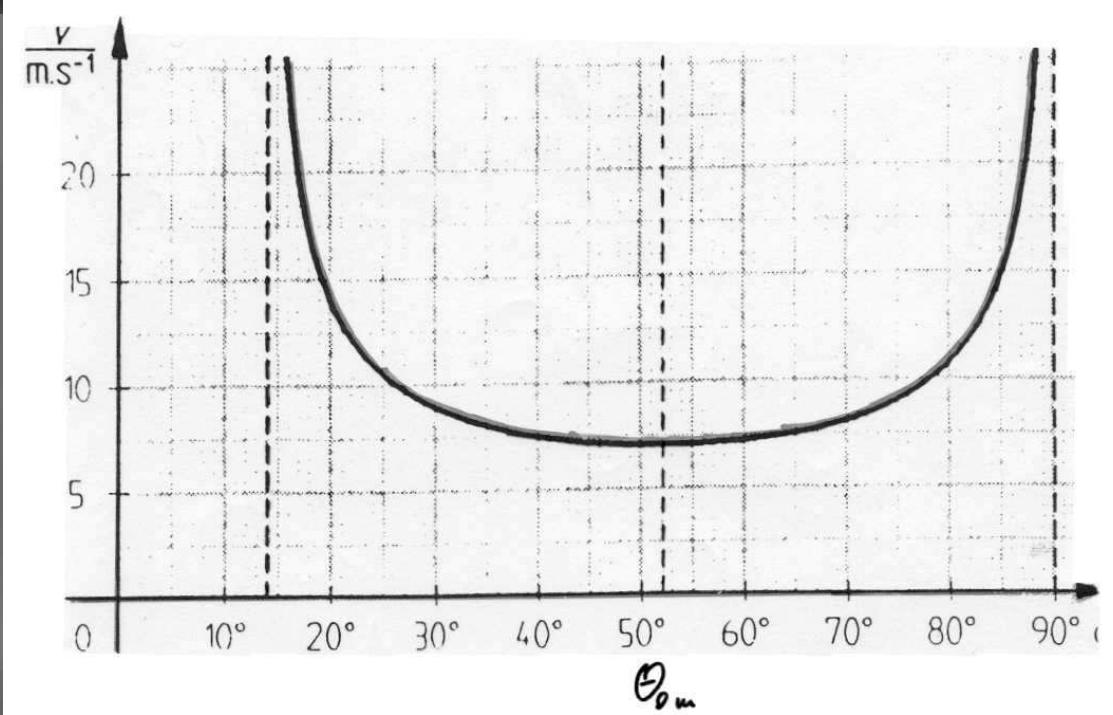
Analyse



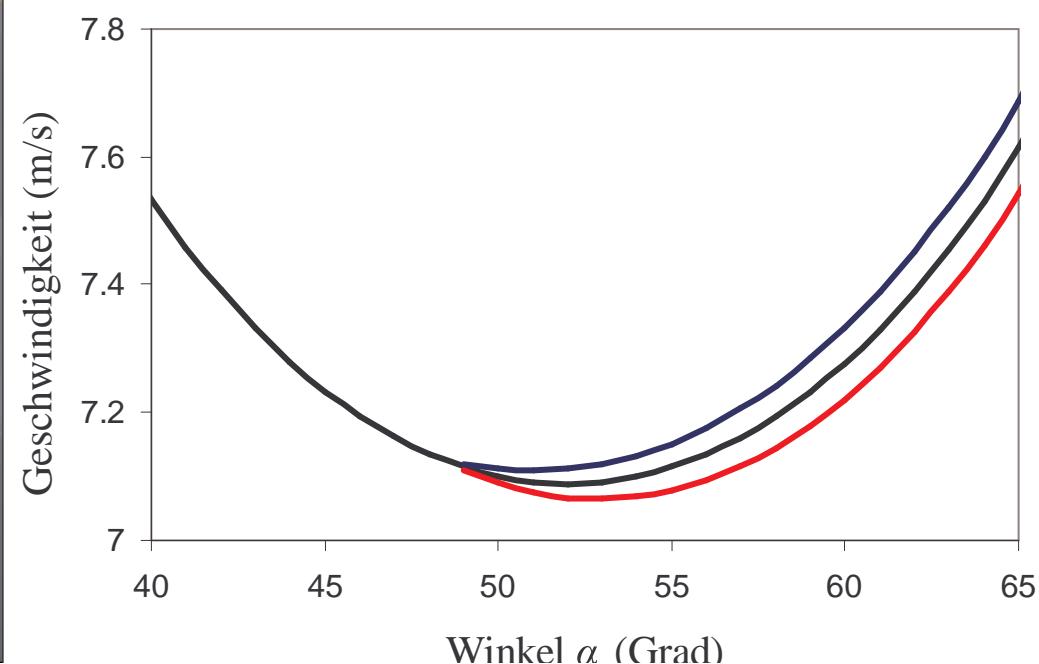


# Basketball Hits

$$v_0^2 = \frac{g \cdot L}{2(\cos\Theta_0)^2 \cdot (\tan\Theta_0 - h/L)}$$



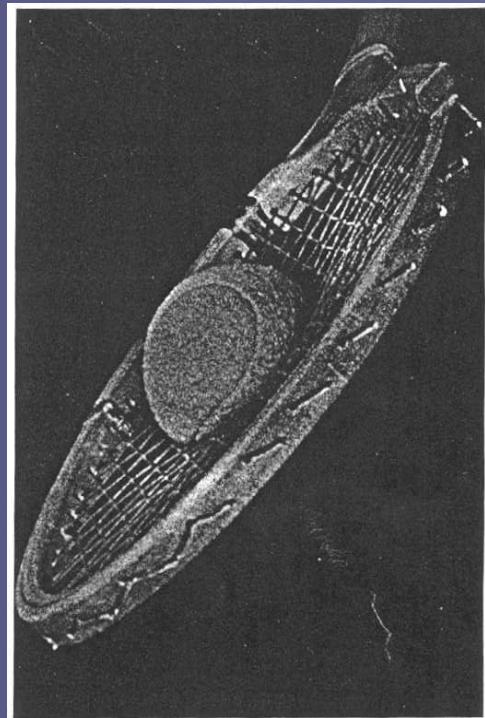
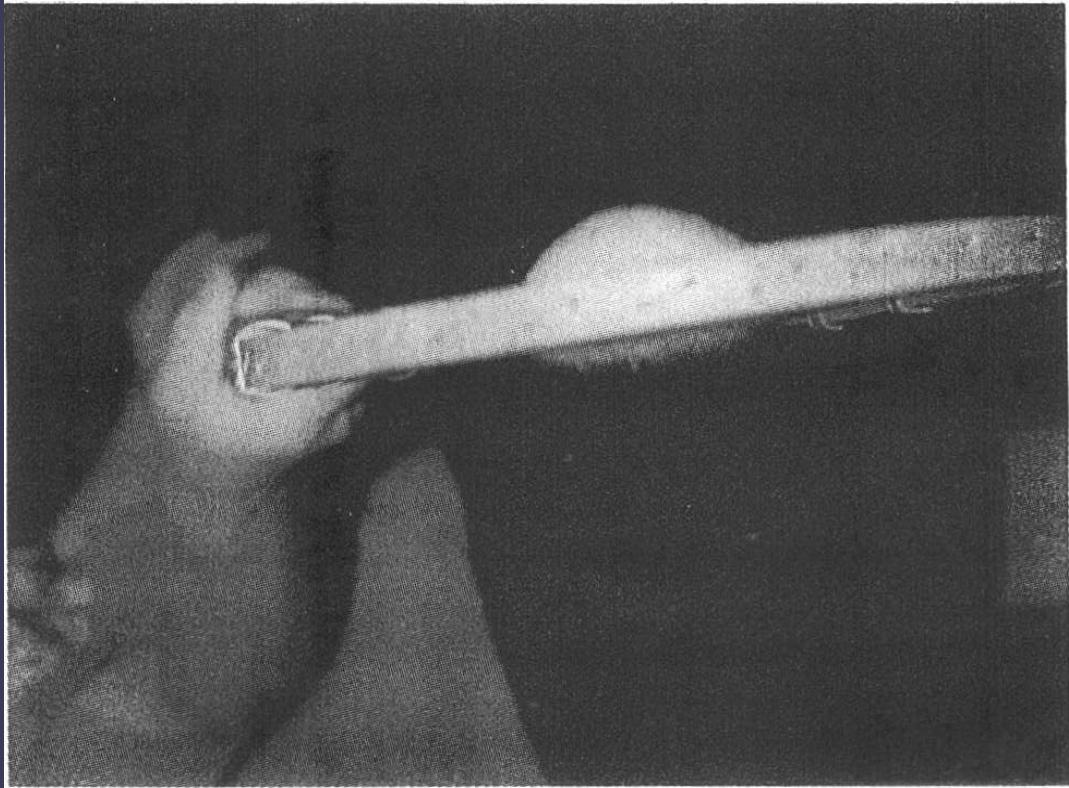
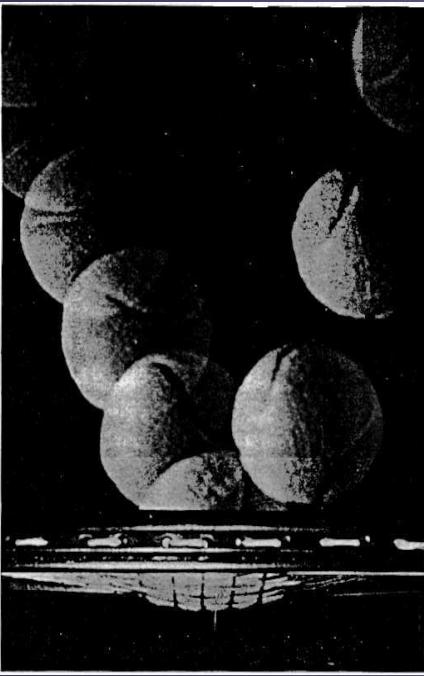
# Basketball Hits



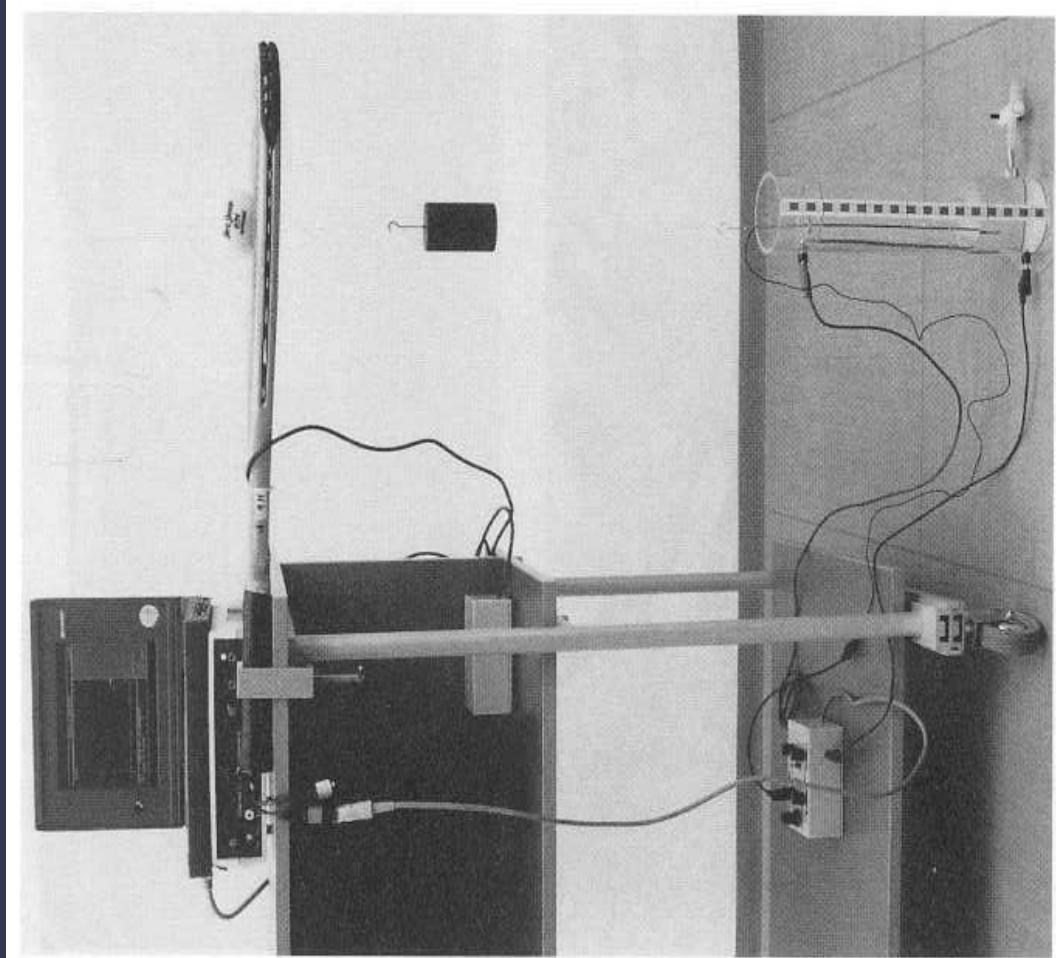
# Billard



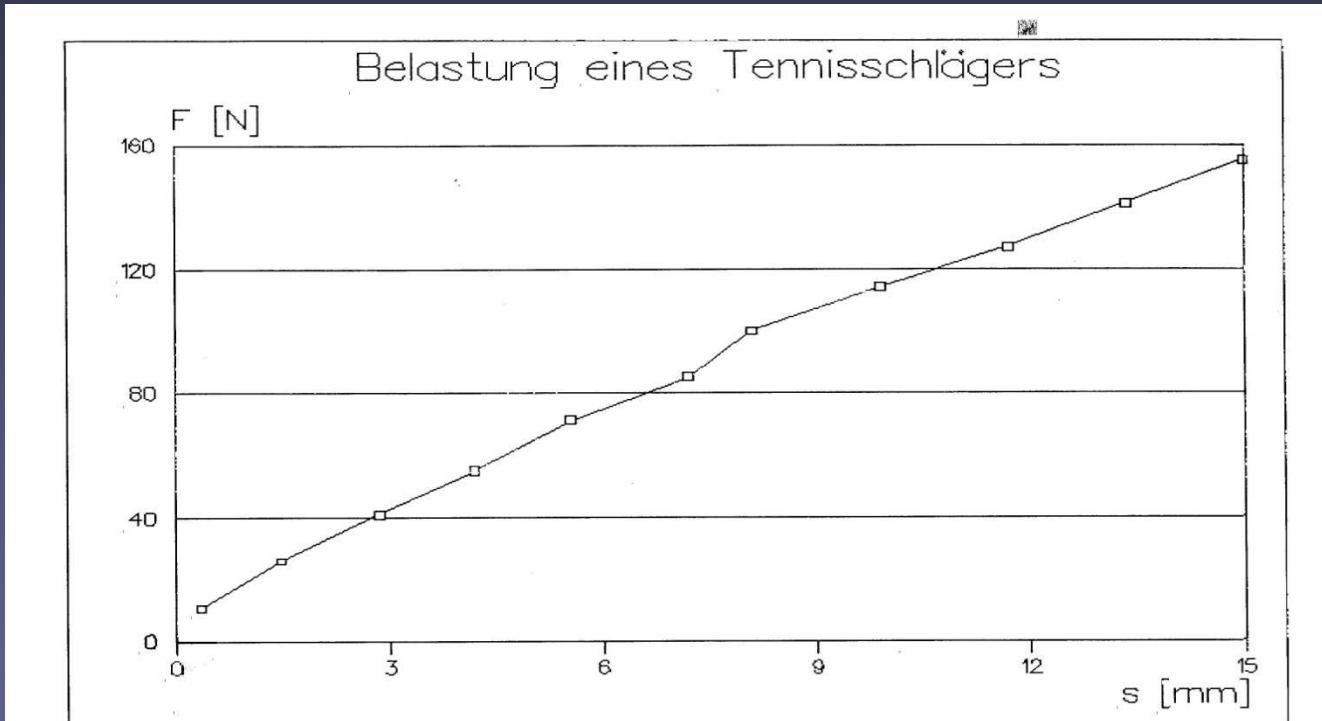
# Tennis Interaction Racquet- Ball



# Racquet



# Force - dislocation



$$T = 2\pi \sqrt{\frac{m}{k}}$$

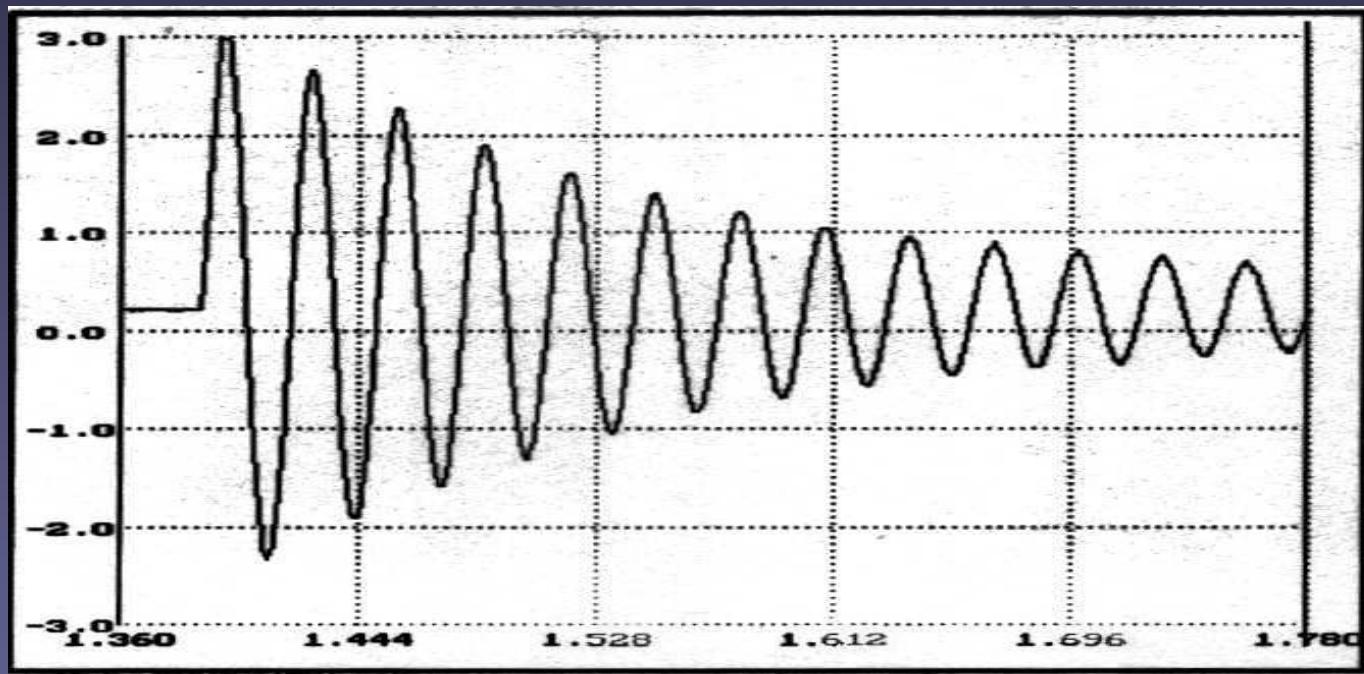
$$\begin{aligned} k &= 10 \text{ kN/m} \\ m &= 0,16 \text{ kg} \end{aligned}$$

$$T = 0,025 \text{ s}$$

# Strain gauge

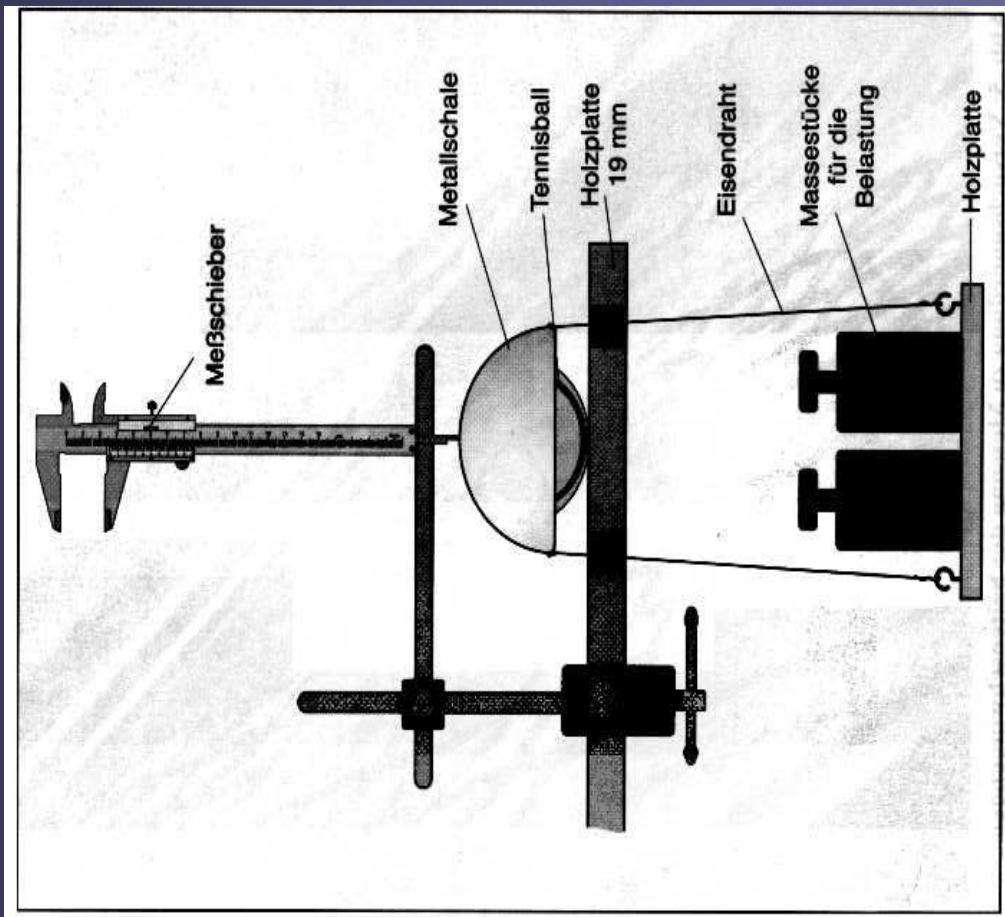


# Oscillations frame

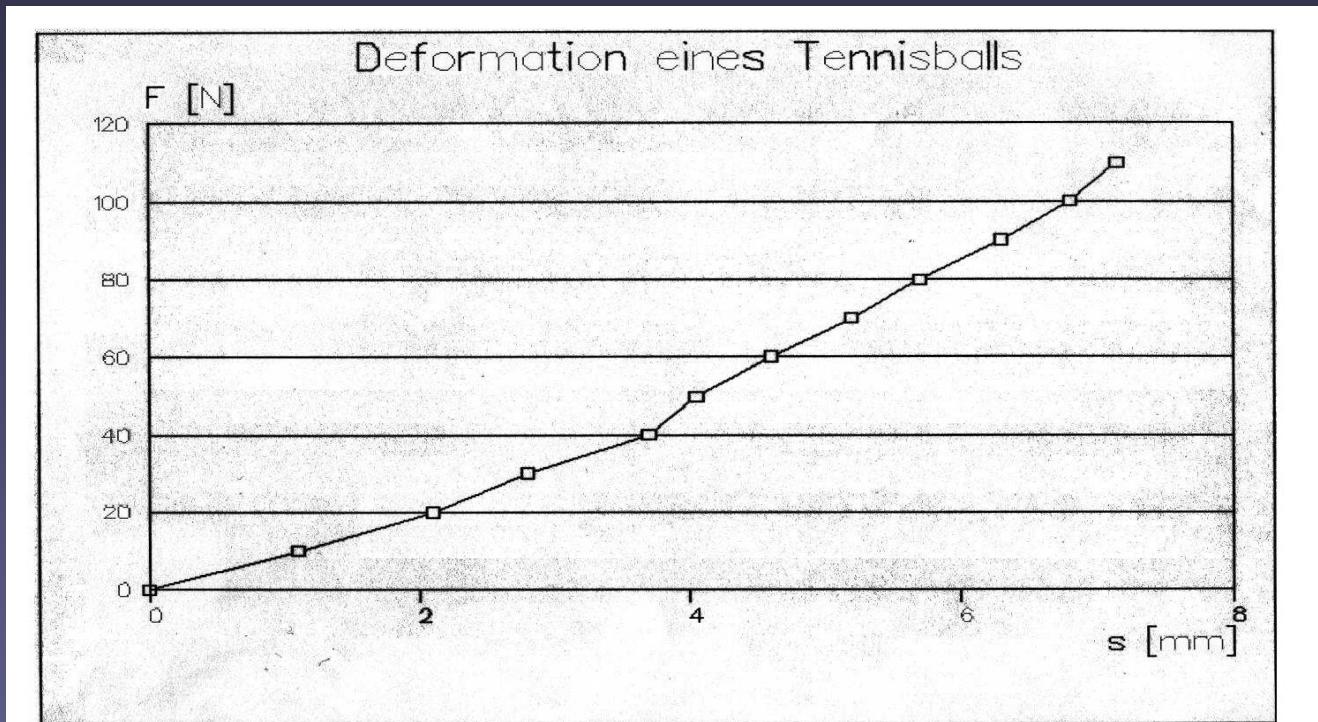


$$T = 0,030 \text{ s}$$

# Elasticity of the ball



# Time of contact



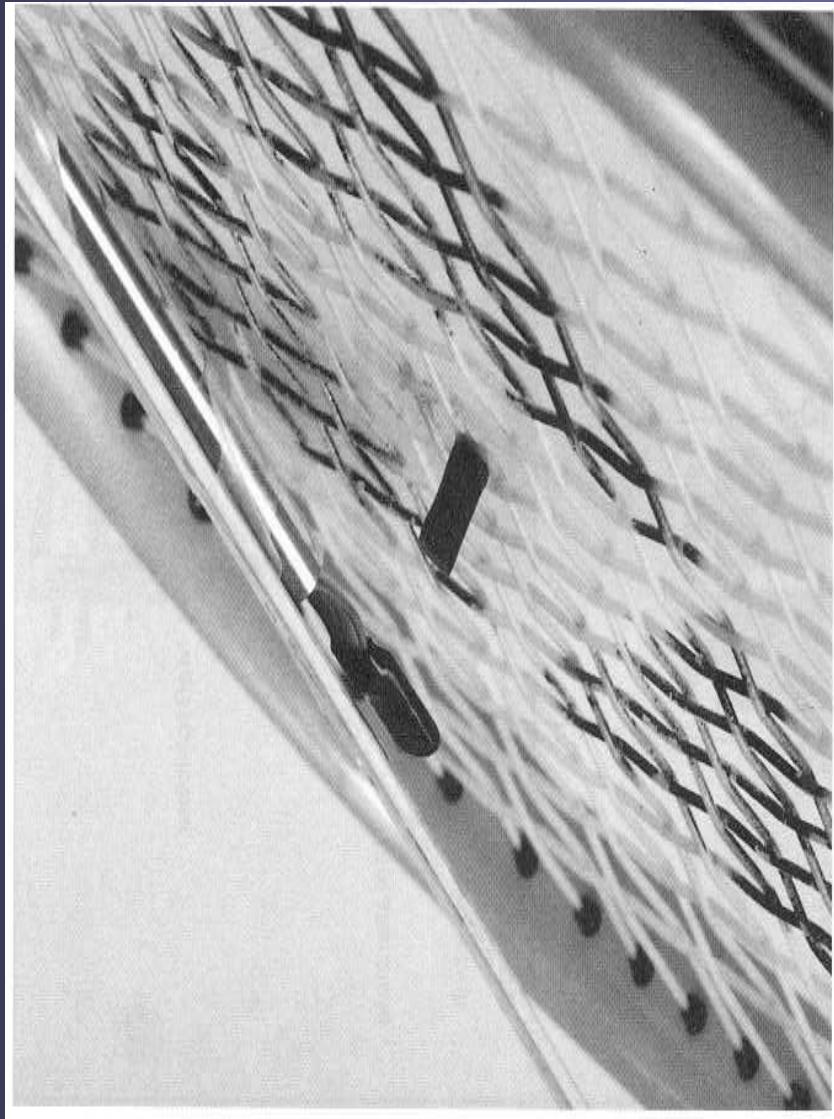
$$k = 15 \text{ kN/m}$$

$$\longrightarrow T = 0,012 \text{ s}$$

$$M = 0,058 \text{ kg}$$

$$\text{Kontaktzeit } \tau = 0,006 \text{ s}$$

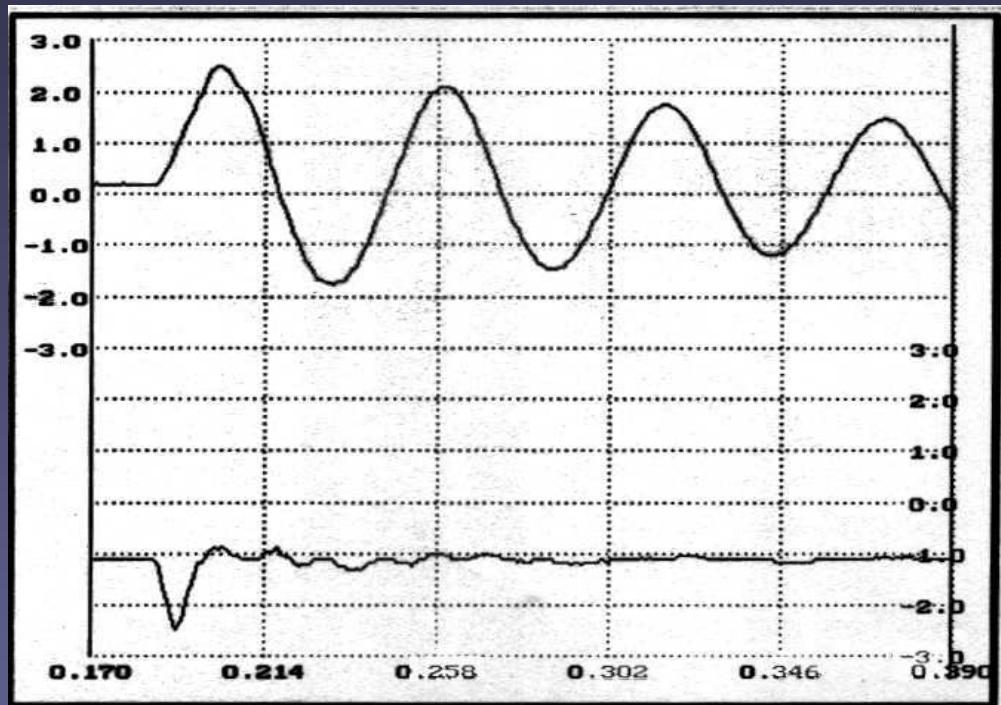
# Hall-sensor



# Oscillations

Frame

Strings



$$T = 0,010 \text{ s}$$

# Tennis-racquet old / new

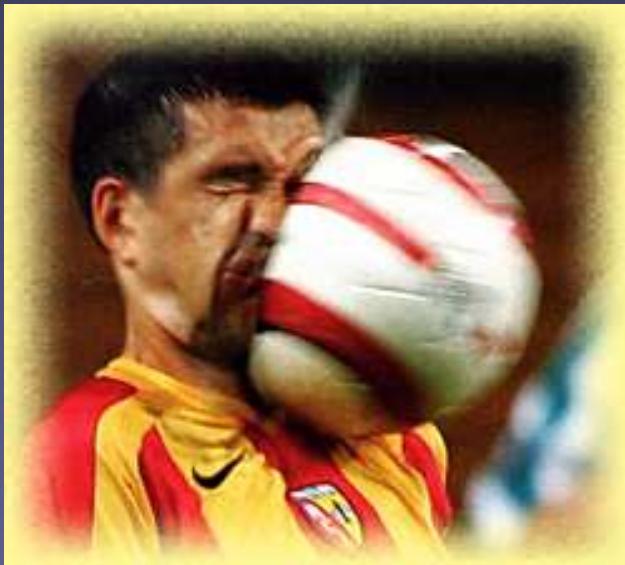
**Stiff  
frame**



# Soccer



# Headers ... healthy?



$$F \cdot \Delta t = 2 \cdot m \cdot v$$

$$m = 0,45 \text{ kg}$$

$$\Delta t = 0,01 \text{ s}$$

$$v = 20 \text{ m/s}$$

$$F = 1800 \text{ N}$$

$$m_{\text{Kopf}} = 6 - 7 \text{ kg}$$

$$a = 280 \text{ m/s}^2 \sim 28 \text{ g}$$

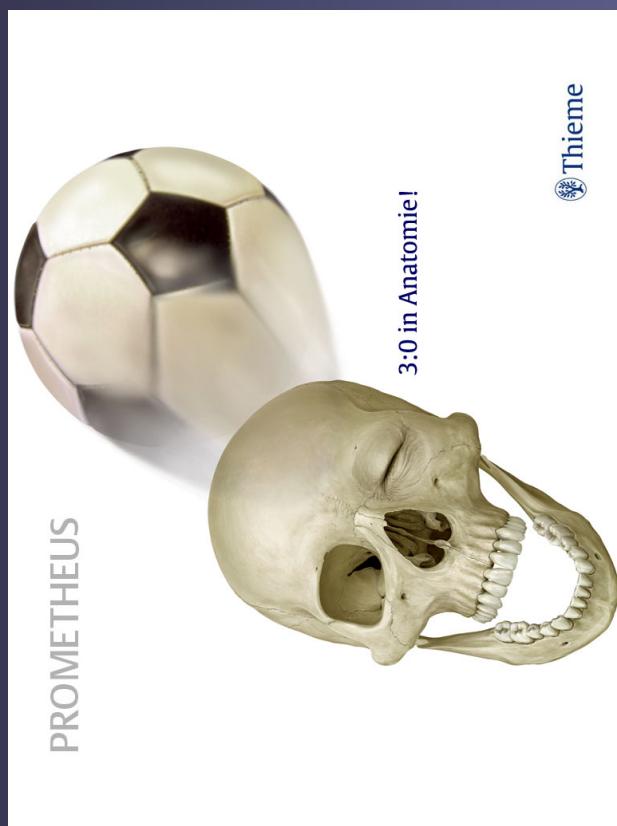
# Effektive mass



# Boxing



# Headers ... healthy?

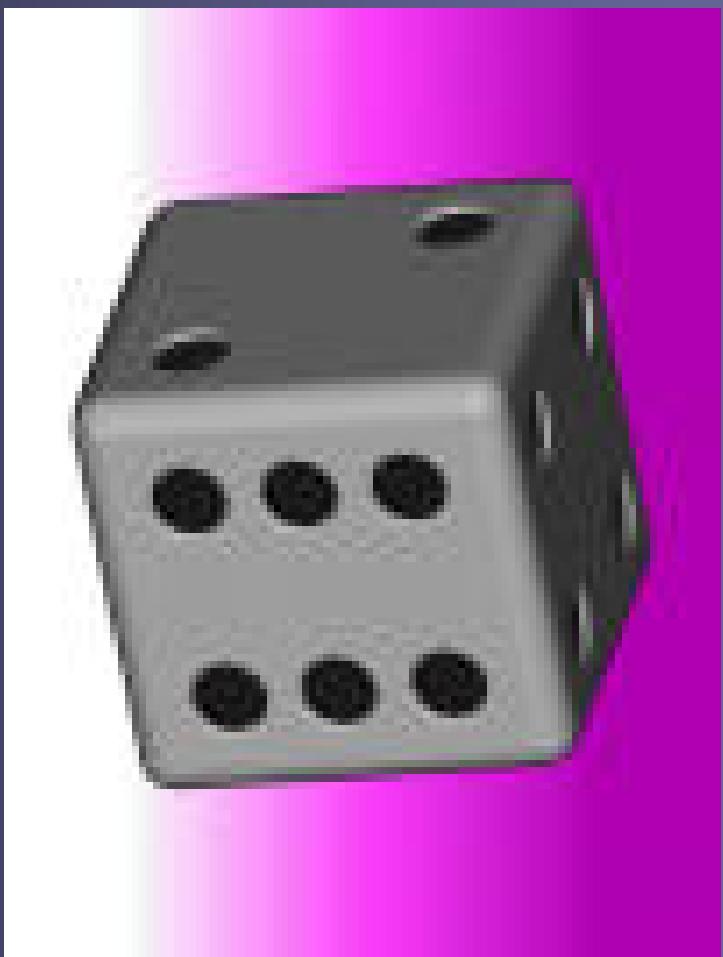


3:0 in Anatomie!

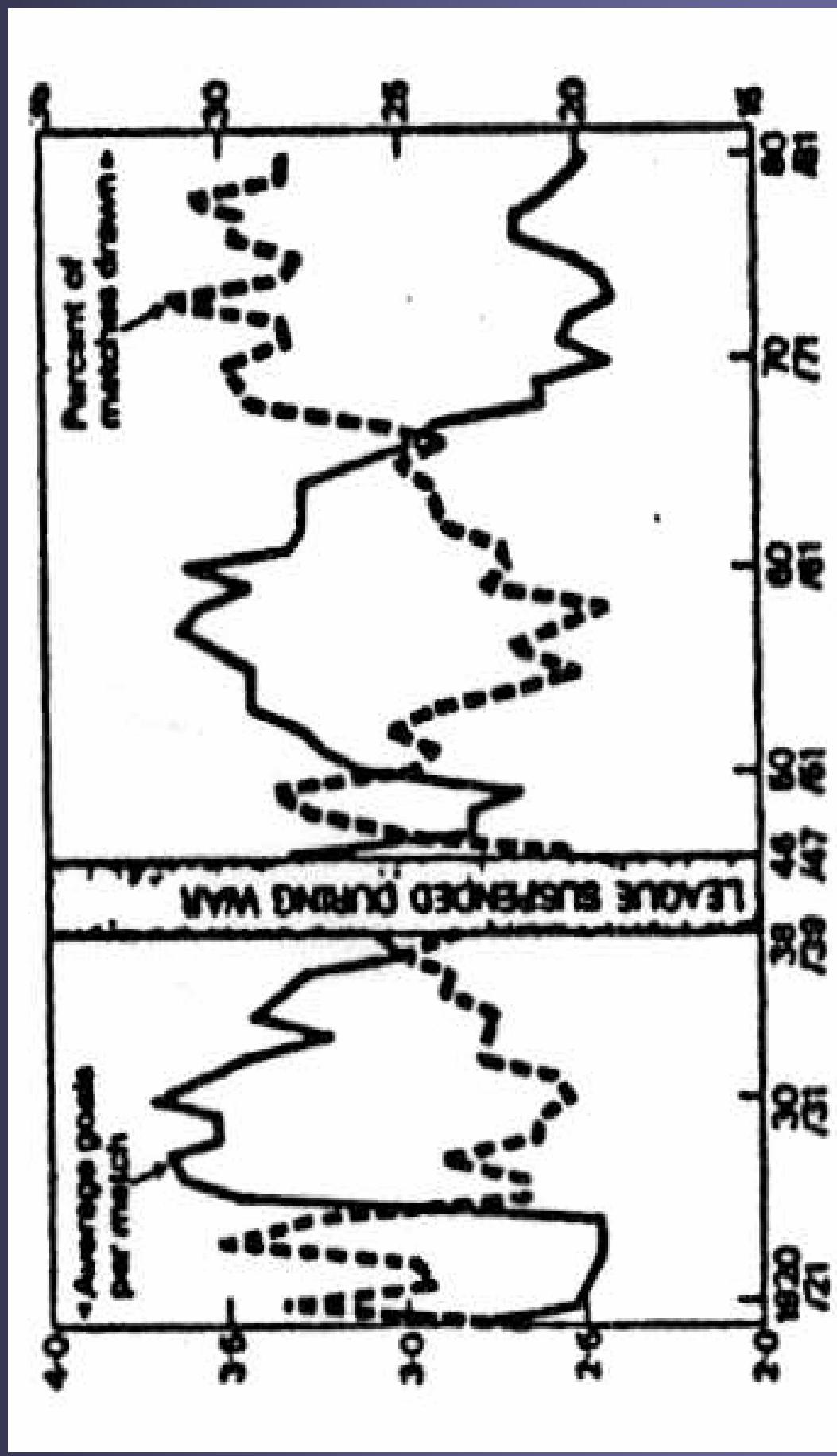
Thieme



**Soccer - by chance?**



# J. Dowie



# Poisson distribution

$$P_k(a) = \frac{a^k}{k!} e^{-a}$$

a average of goals

k number of goals

$P_k(a)$  probability to shoot k goals

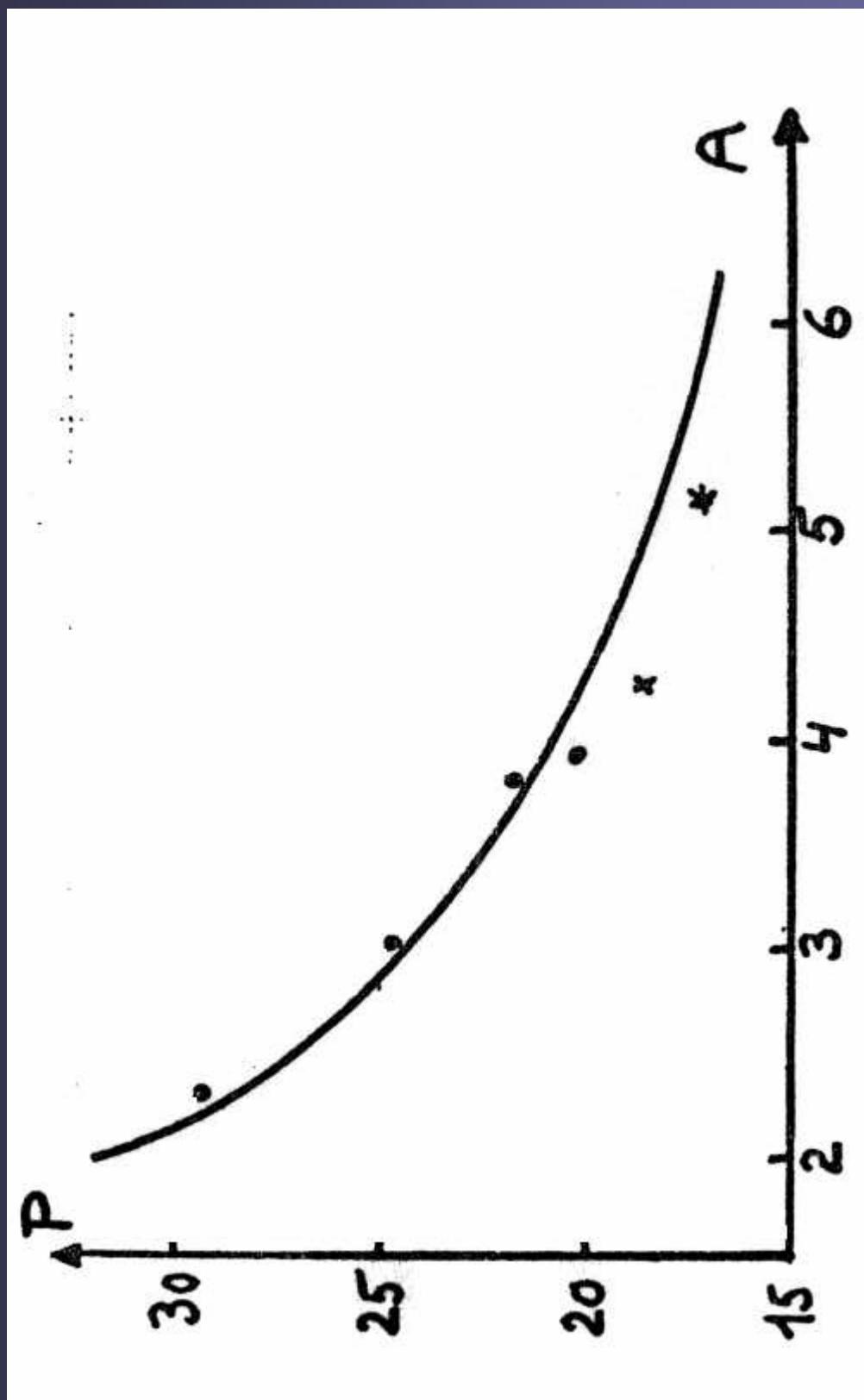
# Probability of goals

Quellenstärke a = 2	
$P_0(2) = e^{-2}$	0,135
$P_1(2) = 2e^{-2}$	0,270
$P_2(2) = 4e^{-2} / 2$	0,270
$P_3(2) = 8e^{-2} / 6$	0,180
$P_4(2) = 16e^{-2} / 24$	0,090

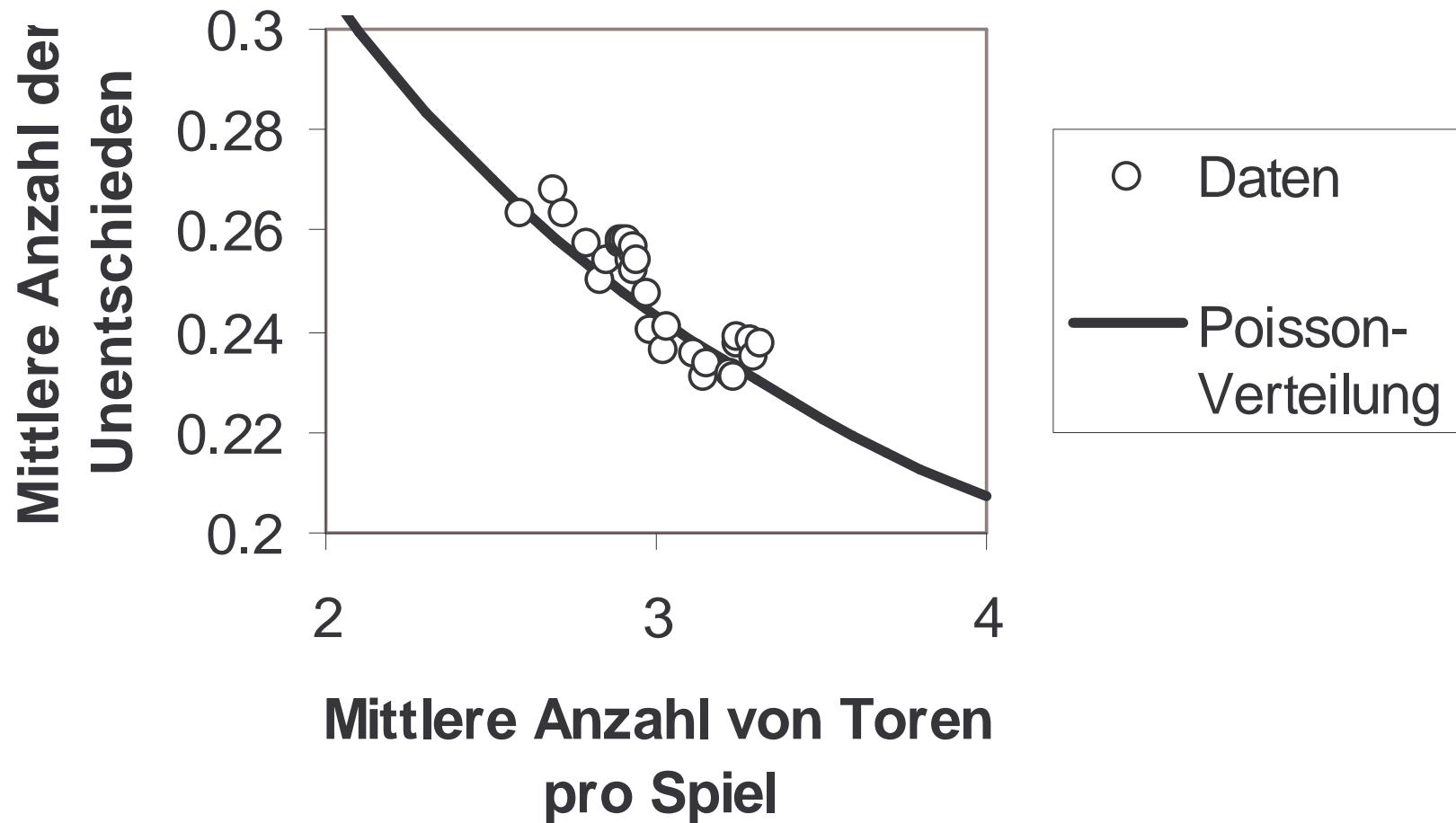
# Probability of games

Quellenstärke $a = 2$	
Ergebnis	Prozent
0:0	1,8
1:0, 0:1, 2:0, 0:2	3,4
1:1, 2:1, 1:2, 2:2	7,3
3:0, 0:3	2,4
3:1, 1:3, 3:2, 2:3	4,9
3:3	3,2
4:1, 1:4, 4:2, 2:4	2,4

# Theory - Experiment



# Deutsche Bundesliga (1965-2005)



# Soccer - by chance ?

Greece

Cup



TOTO