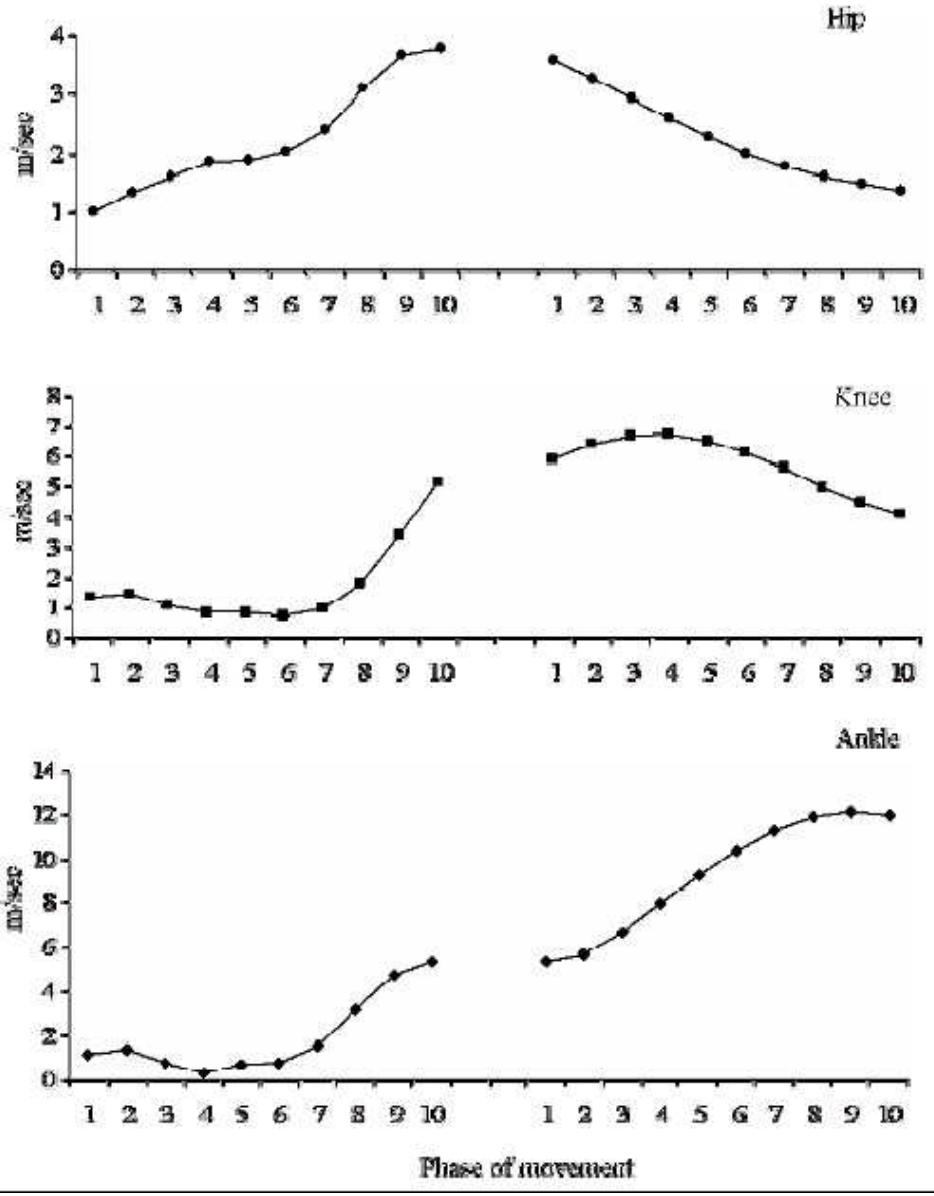
Rúgások

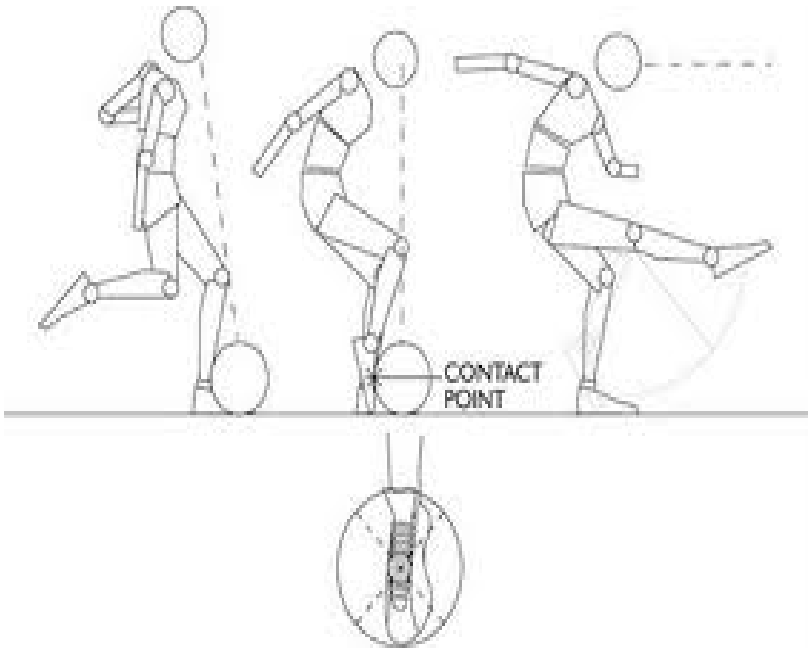
A nem támaszkodó láb ízületeinek együttes, összehangolt mozgása következtében létrejött erő egy másik tárgyra történő átvitele.

A megrúgandó tárgy lehet
Merev (fal, tégla, fa, fém)
Viszkoelasztikus (emberi test)
Rugalmas (labda)

Labda megrúgása

Az egyes ízületek sebessége





Biomechanical characteristics and determinants of instep soccer kick. Eleftherios Kellis.J.Sport S.2007

Forgatónyomatékok az ízületekben

Table 1. Hip flexion, knee extension and ankle plantarflexion moments (N·m) during soccer kicking in adult males as reported in the literature. Data are means (±SD).

Research Study	N	Parameter	Hip flexion	Knee extension	Ankle plantarflexion
Nunome et al. (2002)	5	Average	249 (31)	98 (27)	N/A
		Maximal	283 (30)	111 (39)	
Nunome et al. (2006a)	5	Maximal	309.2 (28.9)	129.9 (25.5)	N/A
Putnam (1991)	18	Average	229 (34)	85 (12)	N/A
Dorge et al. (1999)	7	Maximal	271.3	161.0	N/A
Zernicke & Roberts (1978)	N/A	Maximal	274 (36)	122 (23)	N/A
Robertson (1985)	N/A	Maximal	220	90	N/A
Luhtanen (1988)	29	Maximal	194 (33)	83 (21)	20 (4)
Roberts et al. (1974)	1	Maximal	~269	~68	~10
Huang et al. (1982)	1	Maximal	~250	~80	~20

Labda sebessége

The mechanism of collision between the foot and the ball could be described by the following equation (Lees and Nolan, 1998):

$$V_{ball} = V_{foot} \cdot \frac{M \cdot (1 + \ell)}{(M + m)} \qquad (1)$$

where V_{ball} = velocity of the ball, V_{foot} = velocity of the foot, M = effective striking mass of the leg, m = mass of the ball and ℓ = the coefficient of restitution. The term (1 + ℓ) is related to the firmness of the foot at impact and the ratio M/ (M +m) provides an indication of the rigidity of the foot and leg at impact.

Labda sebessége

$$V_{ball} = \frac{I \cdot V_{f,before} \cdot (1 + \ell)}{I + m_{ball} \cdot r^2)} \qquad (2)$$

where V_{ball} = velocity of the ball, I = the moment of inertia of the shank-foot segment about the knee joint, $V_{f,before}$ = velocity of the foot before impact, ℓ = the coefficient of restitution, m_{ball} = the mass of the ball and r^2 = the distance between the knee joint and the centre of the ball

Labda sebessége

The coefficient of restitution was defined as:

$$\ell \cdot (V_{f,before} - V_{ball,before}) = -(V_{f,after} - V_{ball}) \quad (3)$$

where $V_{f,before}$, the velocity of the foot before impact, $V_{f,after}$, the velocity of the foot after impact and V_{ball} the velocity of the ball

Ütközési koefficiens

A helyreállási koefficiens az ütközés tökéletességét leíró állandó, amely az ütköző testek anyagtulajdonságától függően változik. Tökéletes rugalmas ütközés esetén a Koefficiens 1,0. Valóságos körülmények között futball esetén 0,463-0,681.

(Bull-Andersen etal. 1999, Dorge et al 2002)

Labda sebessége elrúgás után

Table 3. Ball speeds ($m \cdot sec^{-1}$) as reported in the literature (M = Males; F = females). Data are means (±SD).

Research Study	Subject characteristics			Kick	Approach (steps – angle)	Ball speed ($m \cdot s^{-1}$)
	N	Age (Years)	Training status			
Asami and Nolte (1983)	4	N/A	Professional	Instep	N/A	29.9 (2.9)
Narici et al. (1988)	11	25.1 (5.0)	Amateurs	Powerful	N/A	20.0 (3.6)
Opavsky (1988)	6	N/A	N/A	Instep	6-8 steps	23.48 – 30.78
Luhtanen (1988)	29	10.3-17.1	Trained	Instep	2 step	14.9 – 22.2
Kermond & Konz (1978)	1	22	Trained	Punt	2 step	25.8 (2.2)
Isokawa and Lees (1988)	6	20 – 26	Trained	Instep	1 step, 0° 1 step, 45° 1 step, 90°	18.73 (.95) 20.14 (1.58) 19.13 (1.64)
Poulmedis et al. (1988)	11	25.5 (3.0)	Trained	Instep	N/A	27.08 (1.32)
Rodano and Tavana (1993)	10	17.6 (.5)	Professional	Instep	2 step	22.3 – 30.0
Dorge et al. (2002)	7	26.4	Skilled	Instep	3 m, 0°	24.7 (2.5)
Ekblom (1994)	N/A	N/A	Professional	Instep	N/A	32-35
Levanon & Dapena(1998)	6	Inter- collegiate	Experienced	Instep	N/A	28.6 (2.2)
Barfield et al. (2002)	2 M 6 F	19-22	Elite players	Instep	2 step, 45-60°	25.3 (1.51) (M) 21.5 (2.44) (F)
Barfield (1995)	18	20.7 (1.7)	Amateurs	Instep	2 step, 45-60°	26.4 (2.09)
Nunome et al. (2002)	5	High – school	Experienced	Instep	N/A	28.0 (2.1)
Nunome et al. (2006a)	5	16.8 (.4)	Skilled	Instep	N/A	32.1 (1.7)
Nunome et al. (2006b)	9	27.6 (5.6)	Experienced	Instep	N/A	26.3 (3.4)
Apriantono et al. (2006)	7	20.0 (2.1)	Amateurs	Instep	N/A	28.4 (1.6)
Tol et al. (2002)	15	27.4	Amateurs	Instep	N/A	18.9 – 29.8
Roberts et al. (1974)	1	25	Experienced	Toe	2 step	24.09

A térdízület szögsebessége

Table 4. Characteristic values for maximum extension angular velocity of the knee joint reported in the literature. Data are means (±SD).

Research study	Subject characteristics	Knee angular velocity ($deg \cdot s^{-1}$)
Elliott et al. (1980)	4.4 years	1014
	9.9 years	1604
Rodano and Tavana(1993)	Males, Trained	1206 (218)
Barfield et al.(2002)	Males, Trained	1134 (257)
	Females, Trained	1113 (107)
Lees and Nolan (2002)	Males, Trained, high-speed kick	1364 (80)
	Males, Trained, accurate kick	1175 (75)
Levanon and Dapena (1998)	Intercollegiate male players	1805 (289)
Nunome et al. (2002)	High-school male players	1364 (298)
Barfield (1995)	College male players	1587 (280)
Manolopoulos et al.(2006)	Males, Amateur	1874 (155)
Kellis et al.(2006)	Males, Trained	1220 (332)
Rodano and Tavana (1993)	Males, Trained	1206 (218)

A rúgás pillanata

A térd nincs teljesen kinyújtva, szöghelyzet 141±8˚

(Biomechanics Analysis for Right Leg Instep Kick. Ismail A.R. et al. J. appl. Sci. 2010)

Rugásnál létrejövő erők

m_{labda}=0.45kg

$t_{rugás}$=0.05s

$v_{rugás}$=30m/s

$$a = \frac{v}{t} = \frac{30\frac{m}{s}}{0.05s} = 600\frac{m}{s^2}$$

$$F_{átl} = m * a$$

$$0.45kg * 600\frac{m}{s^2} = 270N$$

$$F_{max} = F_{átl} * \sqrt{2} = 381.8N$$

An Introduction to Biomechanics of Sport And Exercise, James Watkins. 2007

A lábizmok által az alsó végtag mozgatásánál kifejtett erő 1, 2, 3 lépéses nekifutásnál

Table 2: The maximum velocity for all run type

Run type	Max. velocity (m sec^{-1})
First step	7.74
Second step	7.88
Third step	8.20

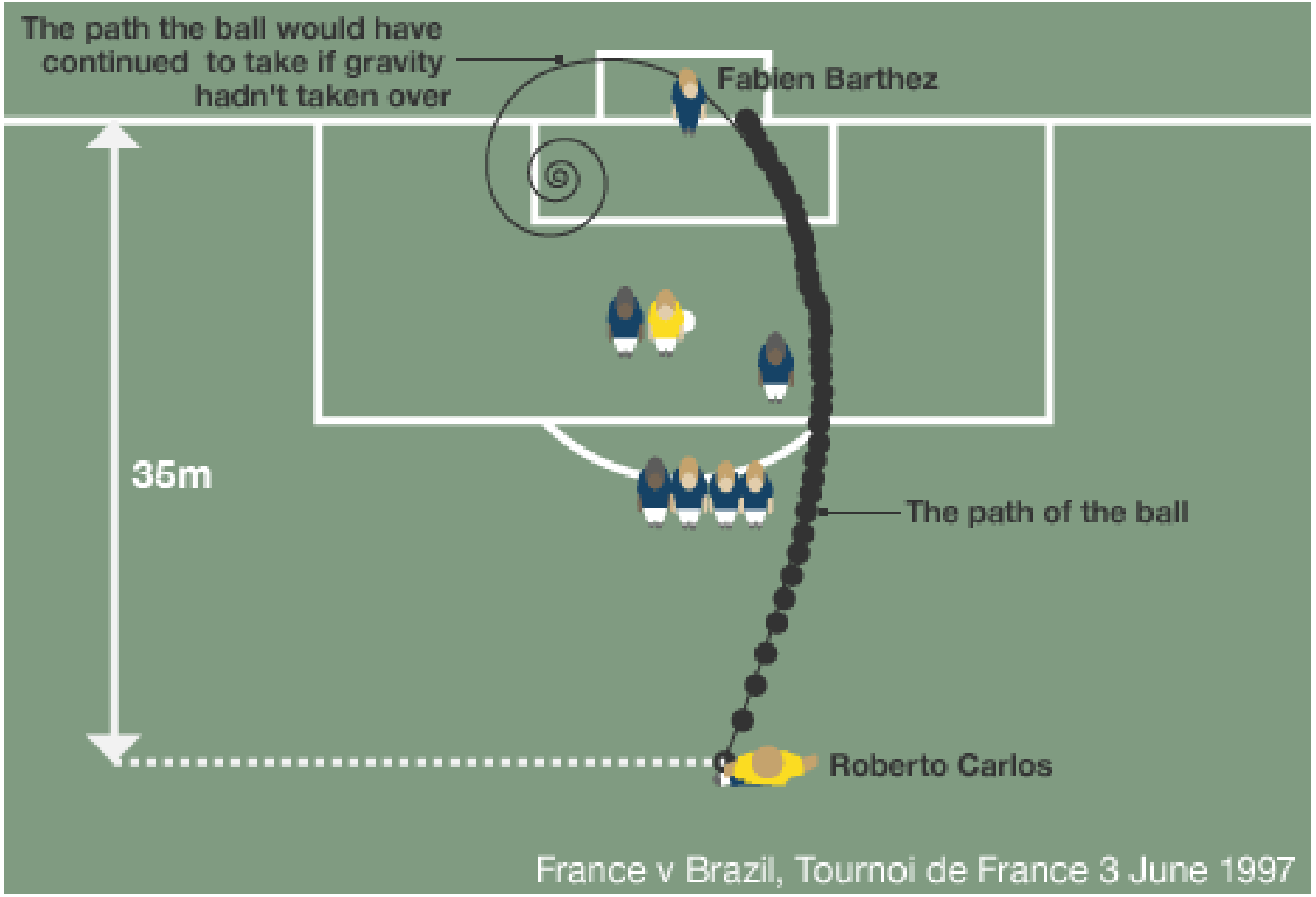
Table 3: The maximum force resultant for each run type

Run type	Max. velocity (m sec^{-1})	Max. force (N)
First step	7.74	5549.850
Second step	7.88	5650.236
Third step	8.20	5879.600

Fejelés

$F_{fejre\ ható}$=200-300N

How Carlos scored an 'impossible' goal



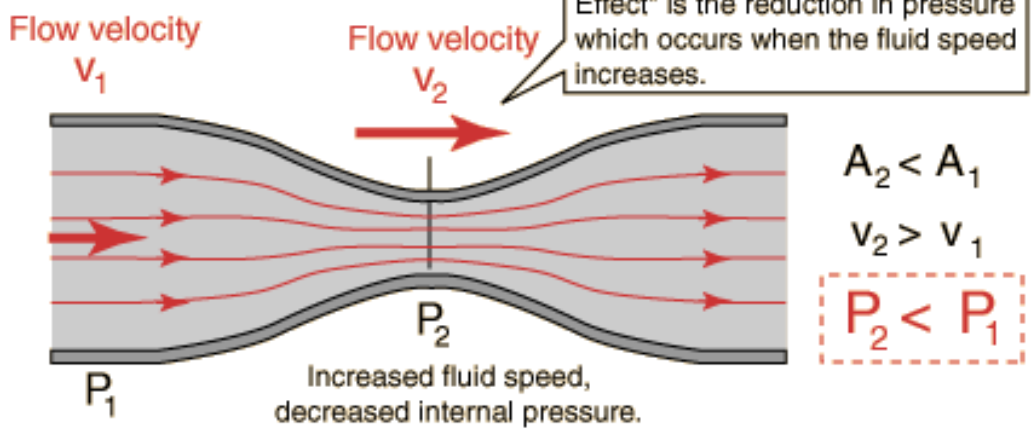
Bernoulli törvény

Energy per unit volume before = Energy per unit volume after

$$P_1 + \frac{1}{2}\rho v_1^2 + \rho g h_1 = P_2 + \frac{1}{2}\rho v_2^2 + \rho g h_2$$

Pressure Energy | Kinetic Energy per unit volume | Potential Energy per unit volume

The often cited example of the Bernoulli Equation or "Bernoulli Effect" is the reduction in pressure which occurs when the fluid speed increases.



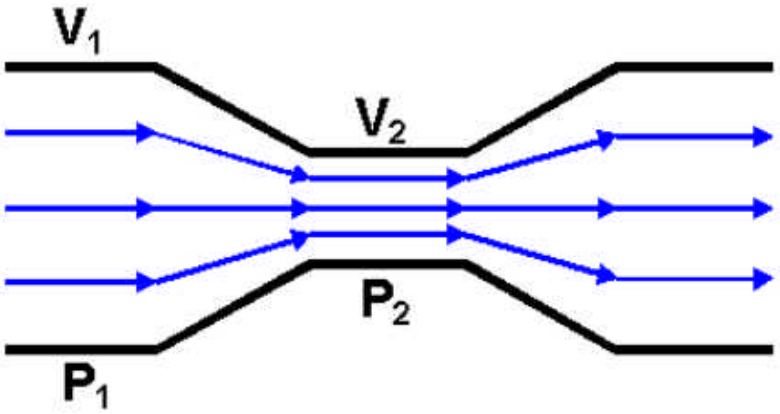
$A_2 < A_1$

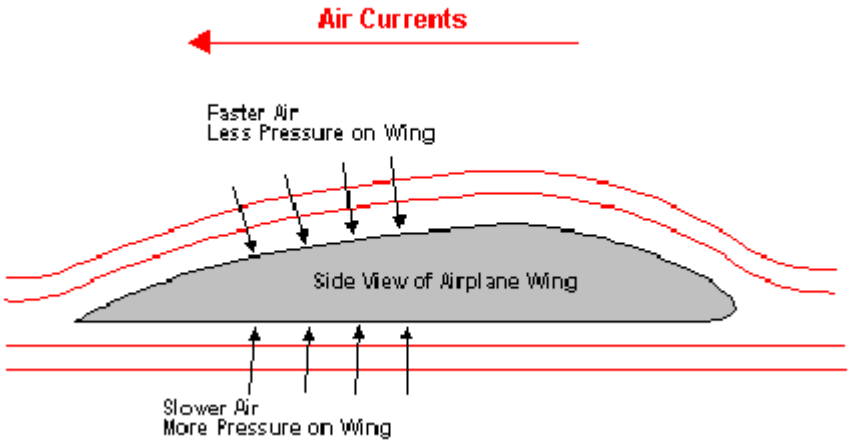
$v_2 > v_1$

$P_2 < P_1$

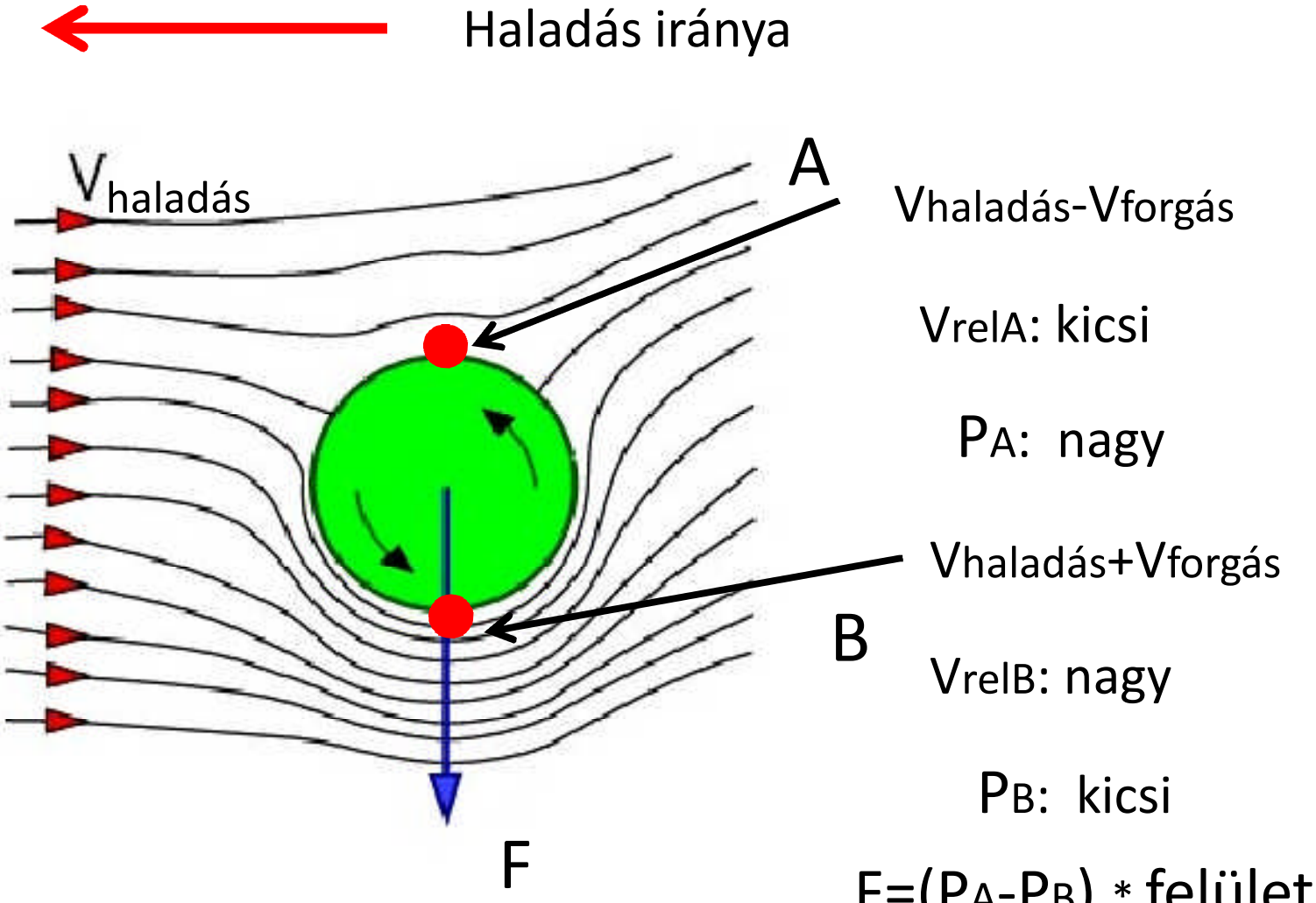
Nagyobb sebesség
kisebb nyomás

Kisebb sebesség
nagyobb nyomás

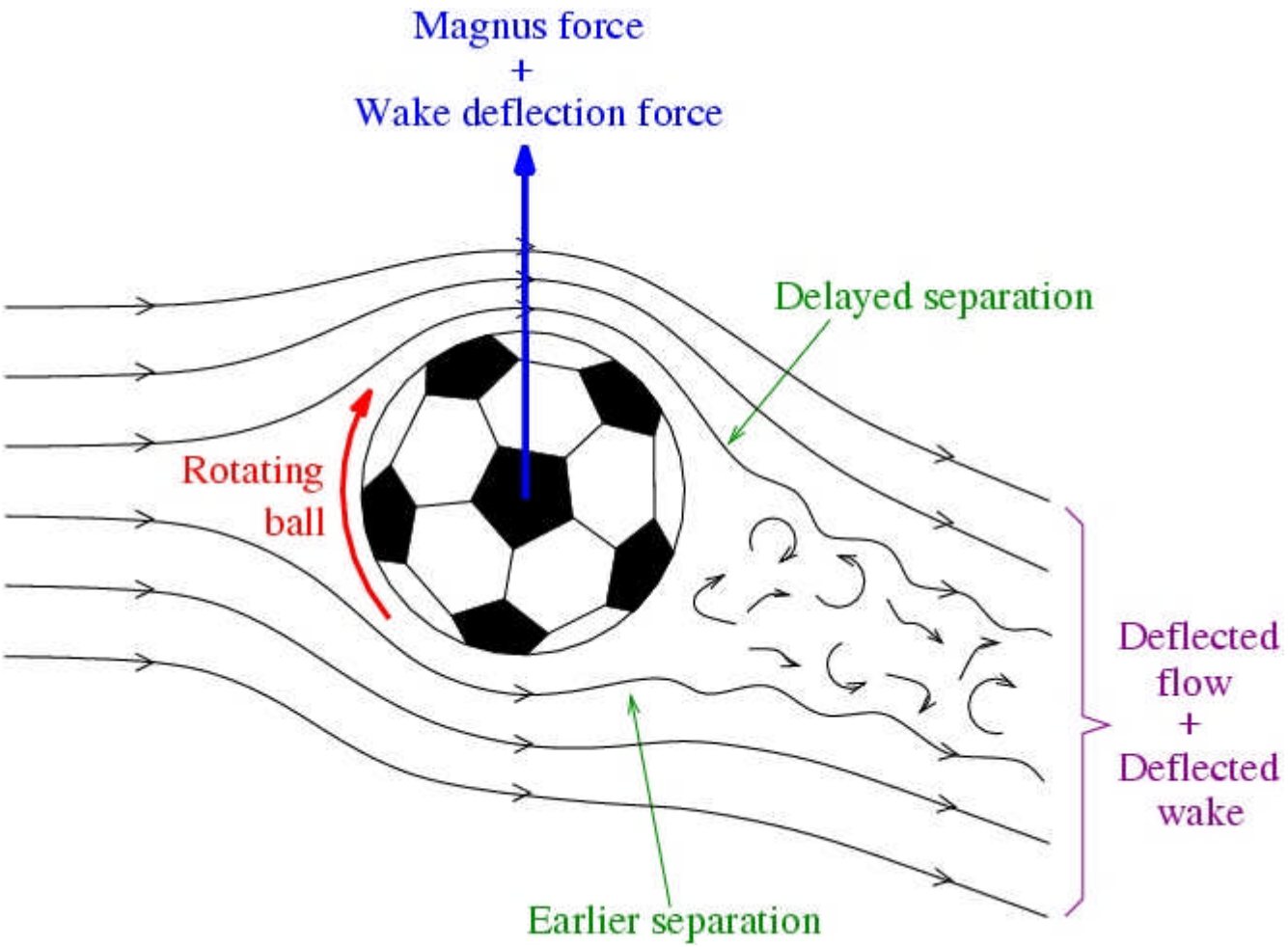




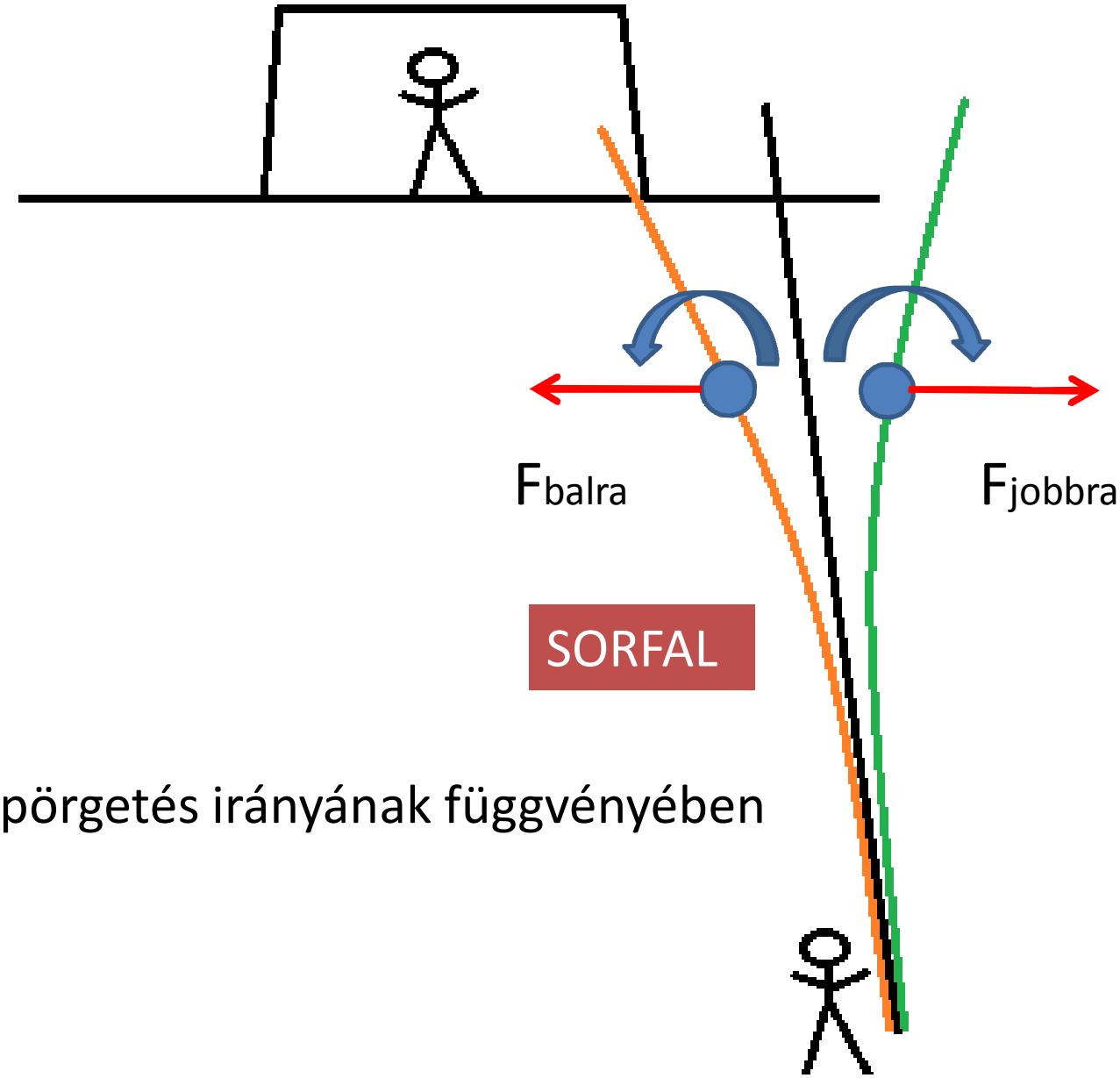
Magnus effektus



Haladás iránya



Labda elkanyarodik (jelenség azonos pl. teniszben, asztaliteniszben)



Labda útja a pörgetés irányának függvényében