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Is it really worth running in the rain?

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Abstract A problem strongly debated between students (and not only students!) is discussed: when one gets caught in a storm without an umbrella, is it worth running as fast as possible to get less wet?

Riassunto E'discusso un problema vivamente dibattuto fra gli studenti (e non solo!): quando scoppia un temporale e si é senza ombrello, mettendosi a correre il piu velocemente possibile ci si bagna davvero meno?

1. Introduction

Everytime one gets caught in the rain without an umbrella the problem of what speed to travel at in order to stay as dry as possible is strongly debated. Even if common sense suggests running as fast as possible, it is frequently objected – especially by people with a good cultural level – that nothing really changes, or maybe running gets people wetter.

The purpose of this paper is to put an end to this kind of useless argument.

2. The model

Let xyz be a reference frame and the rain fall along the negative y direction with a speed v_{0p}, and let d_{0x}, d_{0y} and d_{0z} be the mean distances between the rain drops along the axes.

We represent an experimenter as a rectangular parallelepiped of edges D_x, D_y and D_z travelling along the x axis with speed v for a distance s. The angles between the edges and the coordinated axes are set to zero ('optimal' solutions, cases in which the experimenter assumes strange angles with respect to the ground, are not considered, being awkward to obtain in reality). The overall situation is represented in figure 1(a). When the experimenter moves at a speed v, in the reference frame for which he is at rest the situation appears as in figure 1(b) (projected in the xy plane).

If Θ is the axis defined by the apparent direction of the rain drops and Ψ an axis perpendicular to Θ and z, the following relations hold:

$$\tan\theta = v/v_{0p}$$
$$v_p = v_{0p}/\cos\theta\, u_\Theta$$
$$d_\Theta d_\Psi d_z = d_{0x} d_{0y} d_{0z}$$

where d_Θ, d_Ψ and d_z are the mean distances between the rain drops along Θ, Ψ and z.

The surface which the experimenter exposes to the falling rain (surface perpendicular to u_Θ) can be expressed as

$$S = D_z(D_x\cos\theta + D_y \sin\theta)$$

and thus the number of rain drops per unit time is

$$\frac{dN}{dt} = \frac{Sv_p}{d_\Theta d_\Psi d_z} = \frac{D_z v_{0p}}{d_{0x} d_{0y} d_{0z}} \frac{D_x\cos\theta + D_y \sin\theta}{\cos\theta}.$$

So, if the ground covered requires a time $t = s/v$, assuming

$$\mu = s v_{0p}/d_{0x} d_{0y} d_{0z}$$

the total number of rain drops hitting the experimenter is

$$N = \mu D_z\left(\frac{D_x}{v} + \frac{D_y}{v_{0p}}\right).$$

It appears evident from equation (1) that this number decreases as the speed increases, down to a limit value N_0. In figure 2 N/N_0 is plotted against v/v_{0p}, assuming the ratio D_y/D_x to be equal to 15.

An estimate of v_{0p} is, from (Battan 1962)

$$v_{0p} \leqslant 9 \text{ m s}^{-1}.$$

Now we can use this information to read figure 2. We can see that an experimenter travelling at a speed of 3 m s^{-1} (brisk walk) would get only 10% wetter than another experimenter at a speed of 10 m s^{-1} (world record run).

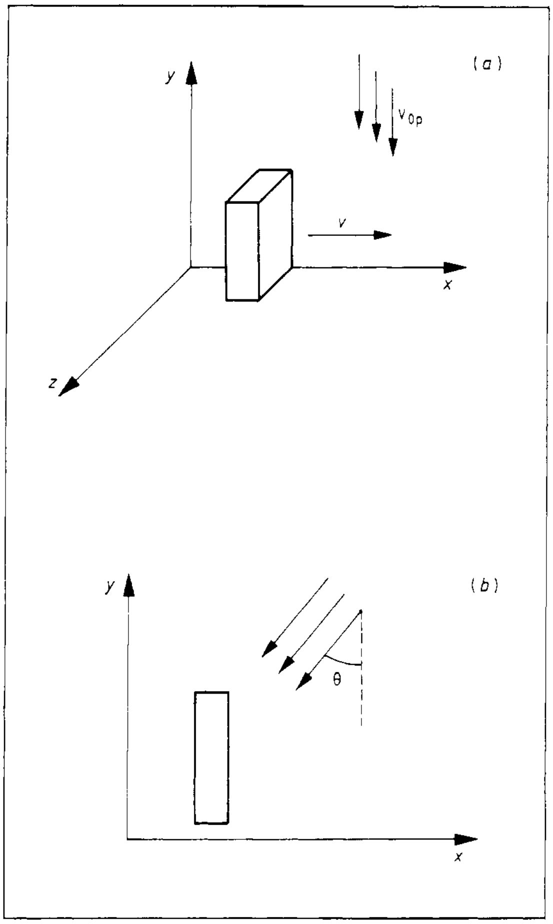

Figure 1 The falling rain in the reference frame in which the experimenter moves at a speed v (*a*) and in the reference frame where he is at rest (*b*).

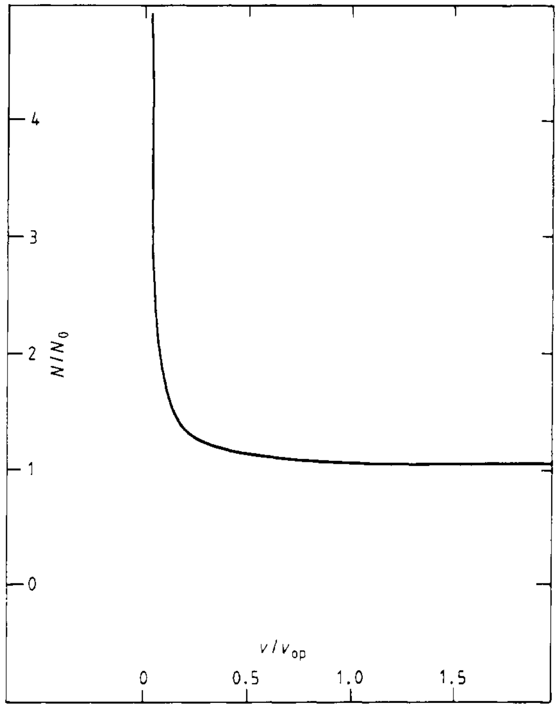

Figure 2 Total number of rain drops hitting the experimenter (in units of the limit value N_0) plotted against his speed (in units of the rain speed v_{0p}).

3. Conclusion

As suggested by common sense, when it is raining it is better to move fast. By running faster you get less wet, but the benefit that you get beyond the speed of a brisk walk does not justify the supplementary effort.

Appendix: Extension to the case of oblique rain

If the speed of the rain has components v_{0px} and v_{0py} on the axes x and y (extending to the case $v_{0pz} \neq 0$ is trivial), equation (1) becomes

$$N = \mu D_z \left(\frac{D_x}{v} + \left| 1 - \frac{v_{0px}}{v} \right| \frac{D_y}{v_{0py}} \right).$$

Notice that, when $v_{0px} > 0$, the choice of a speed $v = v_{0px}$ can be optimal if

$$D_y/D_x > v_{0py}/v_{0px}.$$

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Reference

Battan L J 1962 *Cloud Physics and Cloud Seeding* (New York: Doubleday)