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Official URL: <http://www.euromech.org/conferences/EFMC/EFMC9>

**To cite this version:**

Ern, Patricia and Brosse, Nicolas *The periodic motion of a disk freely falling in a tube*. (2013) In: 9th Euromech Fluid Mechanics Conference (EFMC9), 09 September 2012 - 13 September 2012 (Rome, Italy).

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# The periodic motion of a disk freely falling in a tube

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This study is devoted to the rectilinear and periodic paths of an axisymmetric solid body (short-length cylinder and disk of diameter  $d$ , thickness  $h$  and aspect ratio  $3 \leq \chi = d/h \leq 10$ ) falling in a vertical tube of diameter  $D$ . Three-dimensional trajectography was used to record the body motion (see figure 1). We investigated the influence of the confinement ratio ( $S = d/D$ ) on the characteristics of the body motion, for different aspect ratios and Reynolds numbers ( $80 < Re < 320$ ), and a density ratio between the fluid and the body close to unity. The critical Reynolds number for the onset of the periodic motion decreases with  $S$  in the case of thin bodies ( $\chi = 10$ ), whereas it appears unaffected by  $S$  for thicker bodies ( $\chi = 3$  and 6). For all aspect ratios, the mean fall velocity of the body decreases when  $S$  increases. The characteristics of the oscillatory motion are also strongly modified by the confinement ratio. A thick body ( $\chi = 3$ ) tends to stabilize and to go back to a rectilinear path when the confinement ratio increases, while a thin body ( $\chi = 10$ ) displays oscillations of growing amplitude with  $S$  until it touches the tube (at about  $S = 0.5$ ). However, the amplitudes of the oscillatory motion of bodies with a given aspect ratio gather on a unique curve for all  $S$  (including the case with no confinement,  $S = 0$ ), when plotted as a function of the relative distance of the Reynolds numbers of the bodies to the threshold of path instability for each confinement ratio  $S$ .

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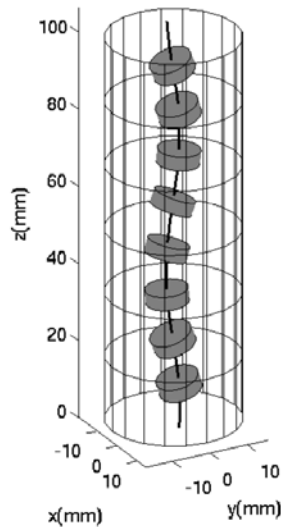


Figure 1: Three-dimensional view of the path of a body of aspect ratio  $\chi = 3$  falling in a tube with  $S = 0.32$  and  $Re = 245$ . The grid represents the wall of the tube.