Rotating flows

Sir Geoffrey Ingram Taylor
(7 March 1886 – 27 June 1975)

Experiments on the Motion of Solid Bodies in Rotating Fluids.

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one. On the other hand, if an attempt is made to produce a slow steady motion by moving a three-dimensional body† with a small uniform velocity (relative to axes which rotate with the fluid) three possibilities present themselves :—

(*a*) The motion in the liquid may never become steady, however long the body goes on moving.

(*b*) The motion may be steady but it may not be small in the neighbourhood of the body.

(*c*) The motion may be steady and two-dimensional.

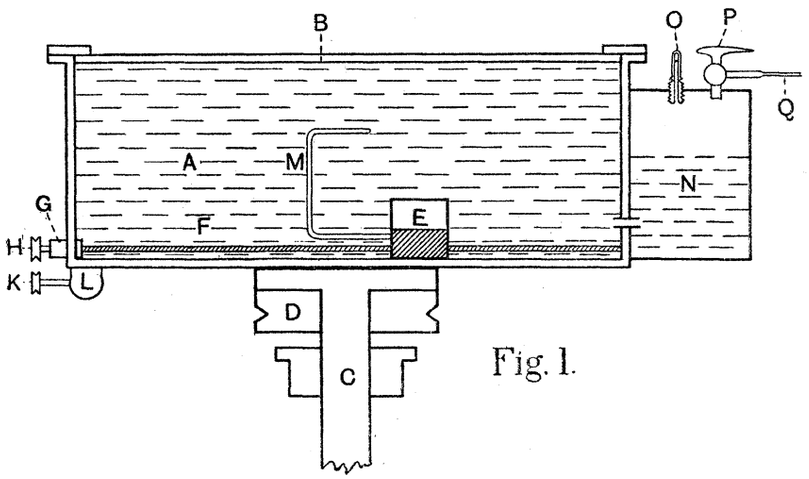

Fig. 1.

There remains the third possibility (*c*). In this case the motion would be a very remarkable one. If the liquid were contained between parallel planes perpendicular to the axis of rotation, the only possible two-dimensional motion satisfying the required conditions is one in which a cylinder of fluid moves as if fixed to the body. The boundary of such a cylinder would act as a solid body, and the liquid outside would behave as though a solid cylindrical body were being moved through it. No fluid would cross this boundary, and the liquid inside it would, in general, be at rest relative the solid body. This idea appears fantastic, but the experiments now to be described show that the true motion does, in fact, approximate to this curious type.

$$\mathrm{Ro} = \frac{U}{\Omega L} \ll 1.$$

Taylor - Proudman

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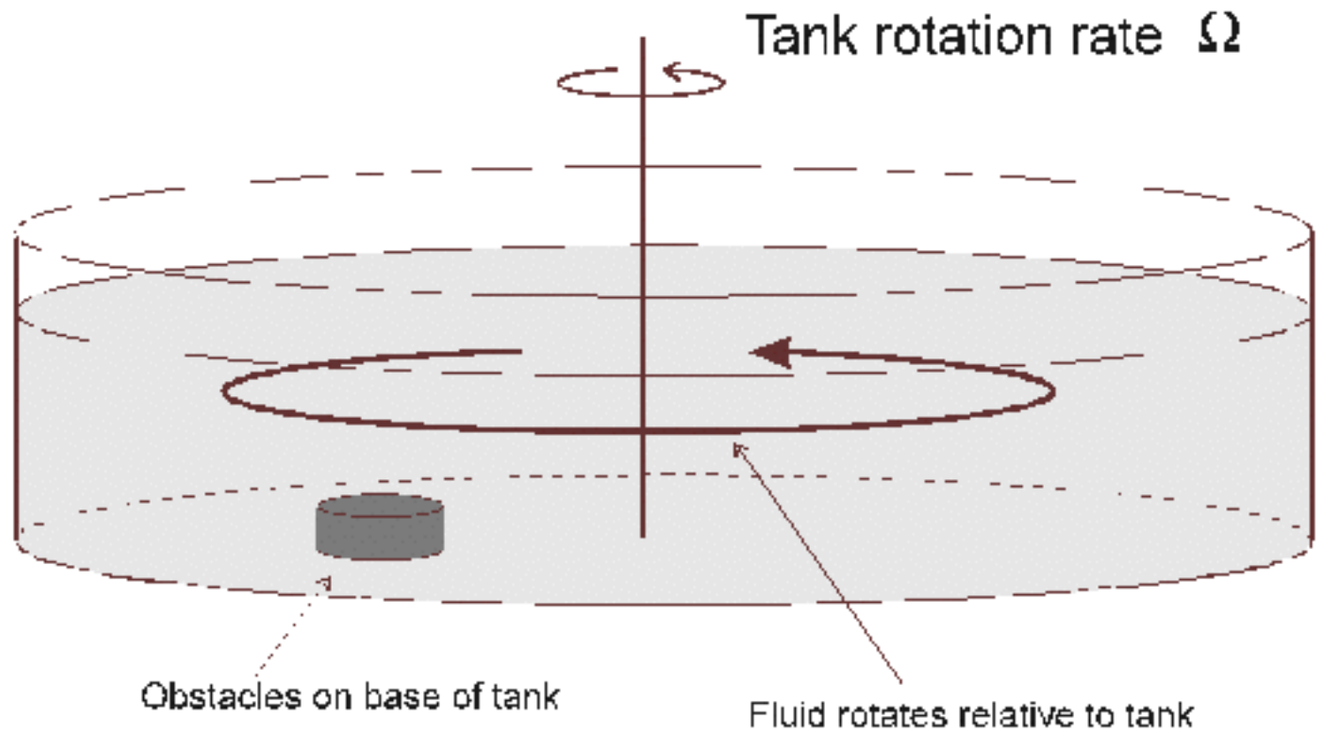

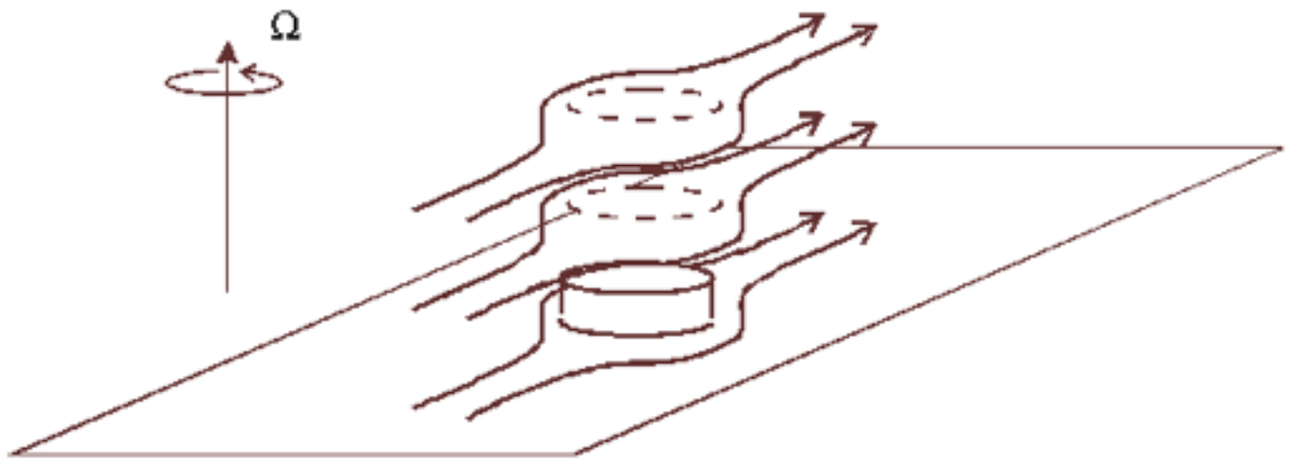

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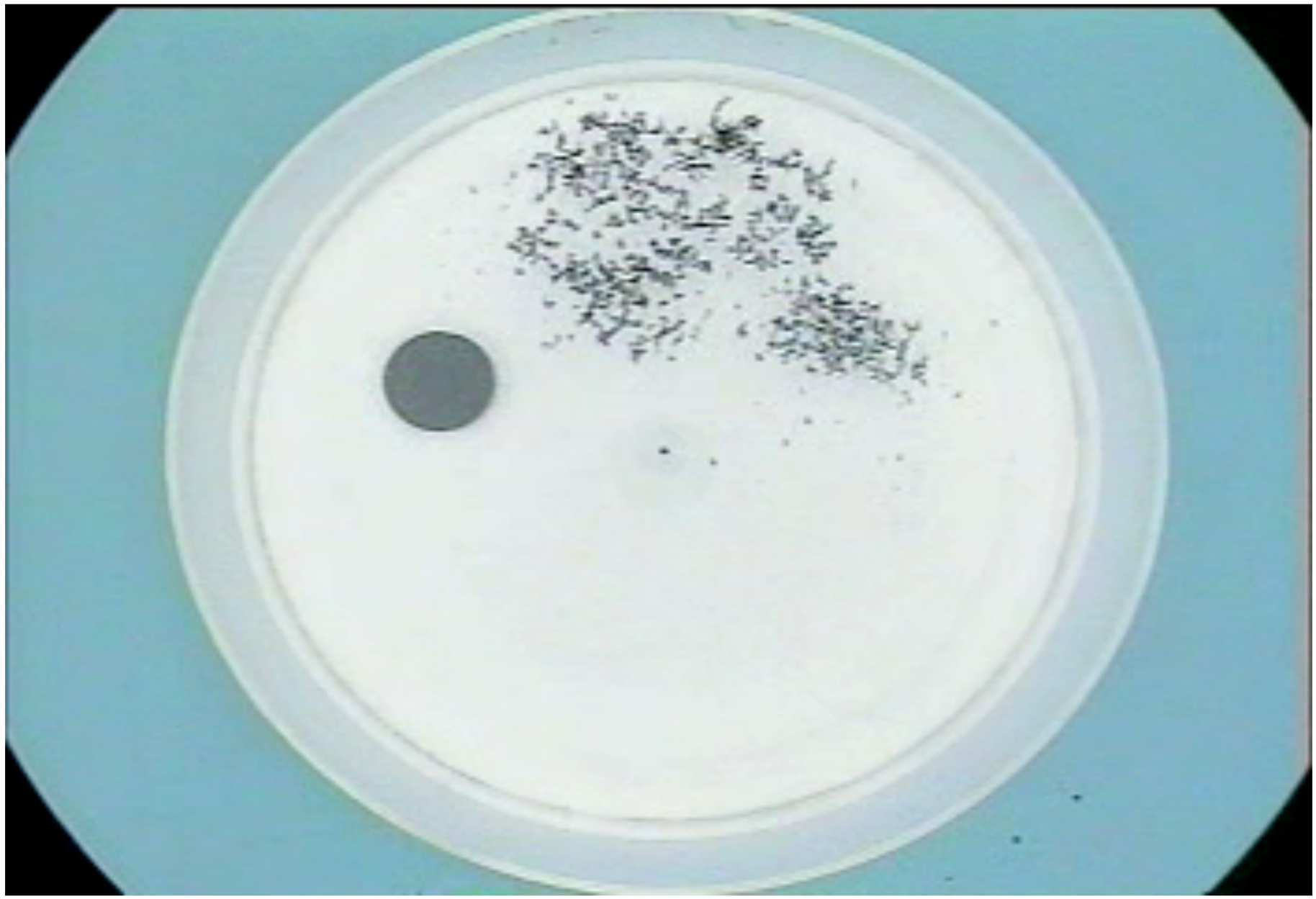
Taylor - column



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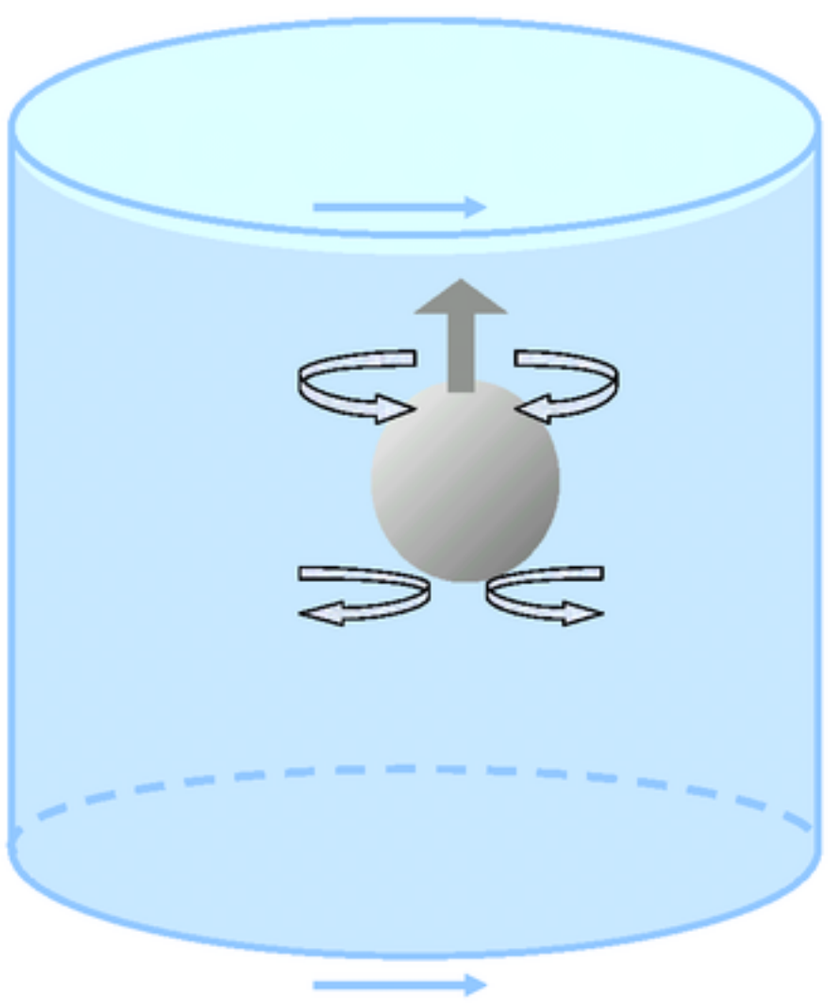
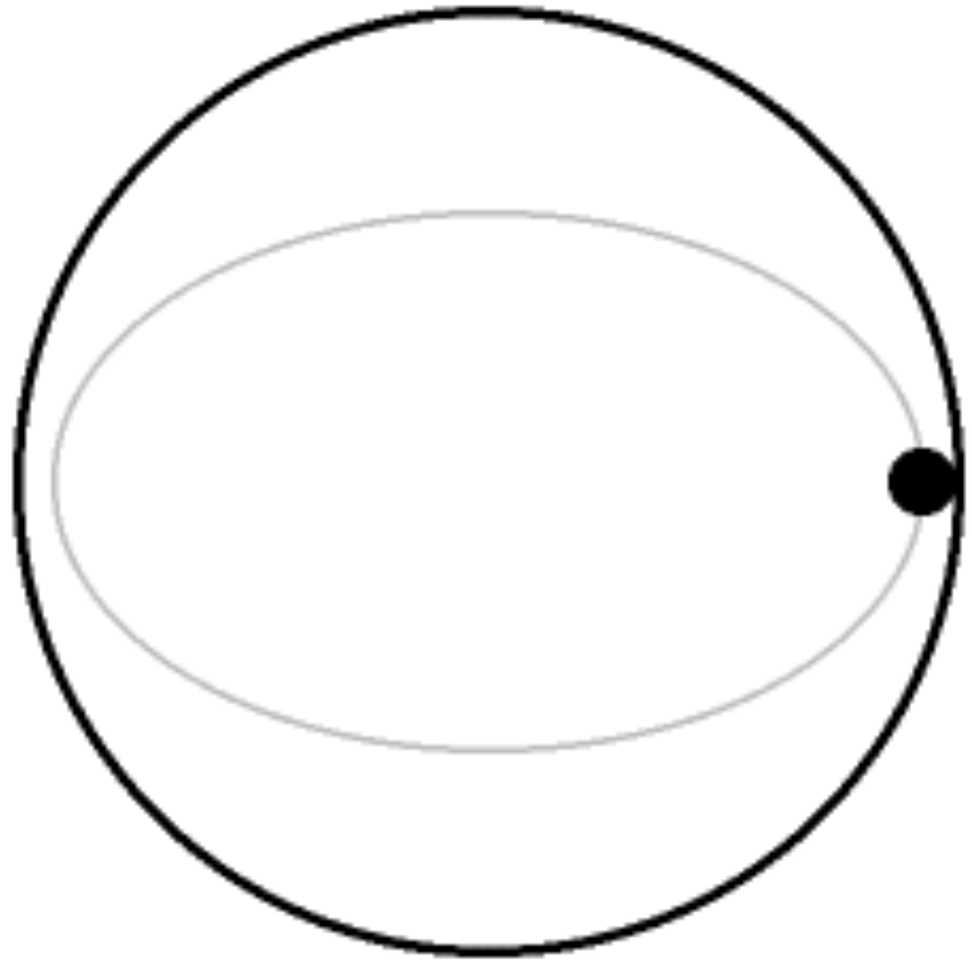
Taylor - column





A rotating fluid has a specific kind of rigidity, it does not quite act like a fluid anymore

Ekman-Layer

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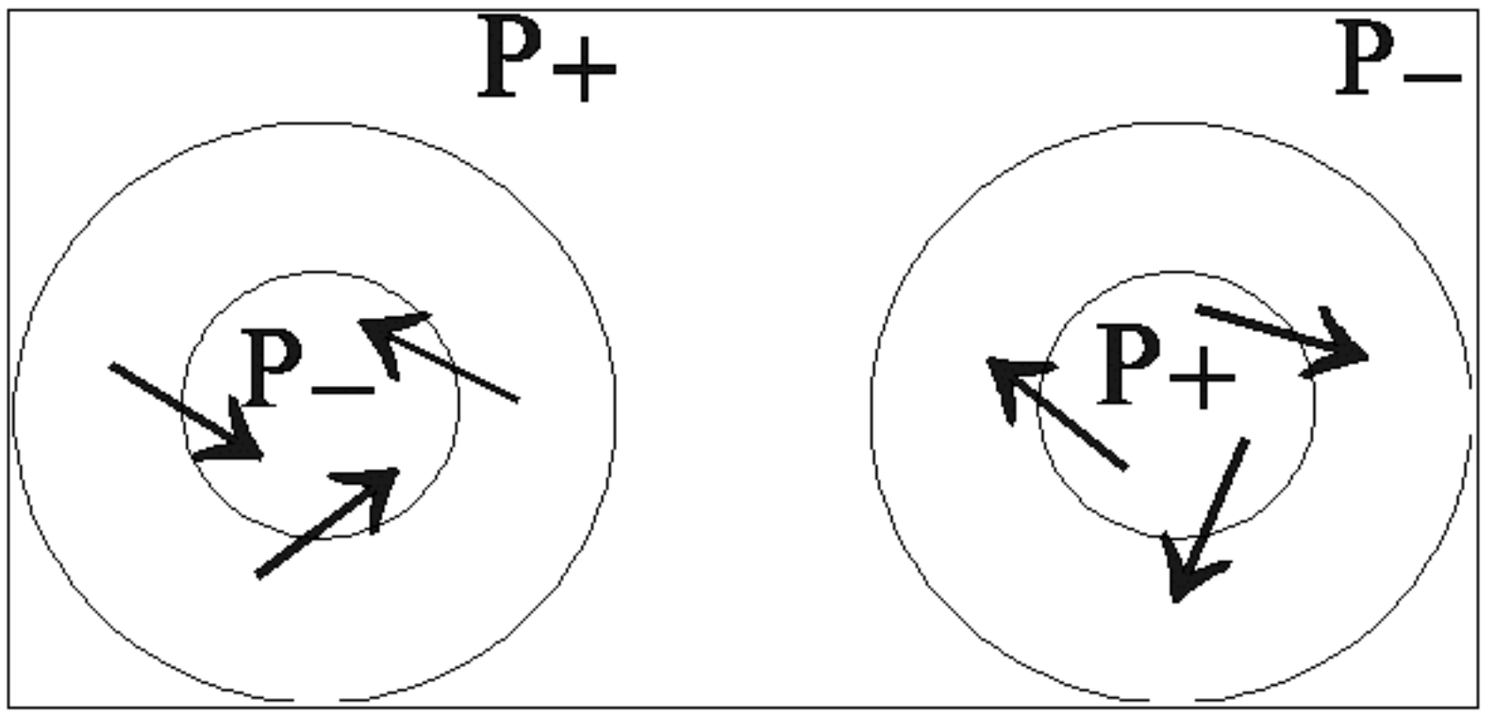

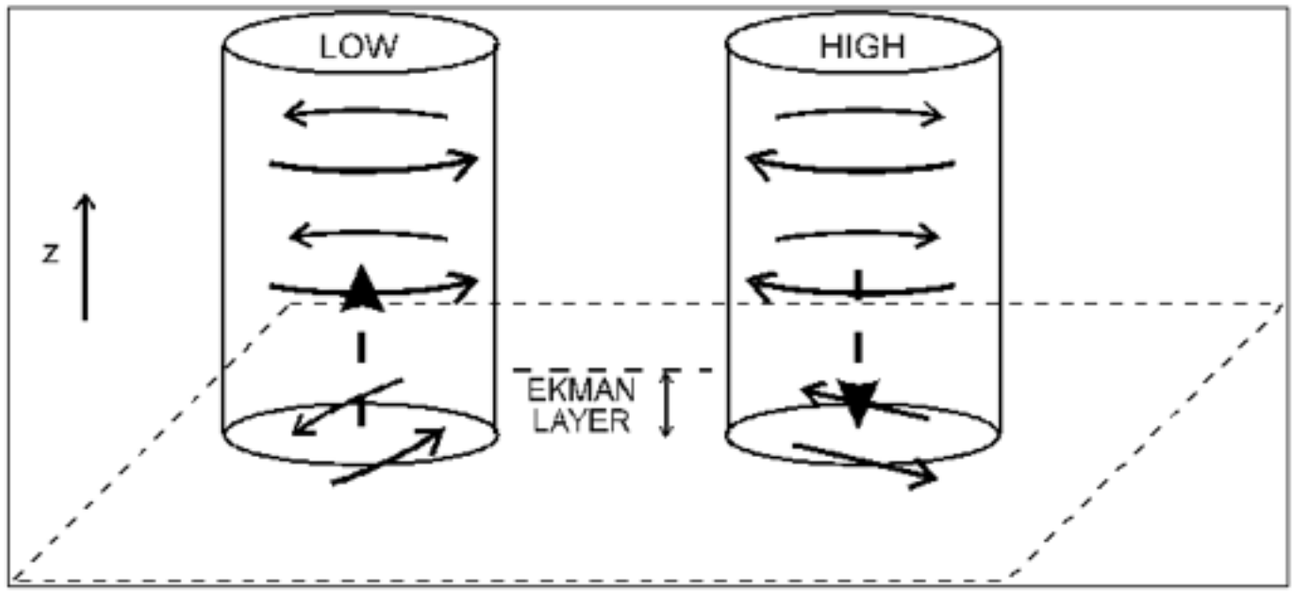

Ekman-Layer

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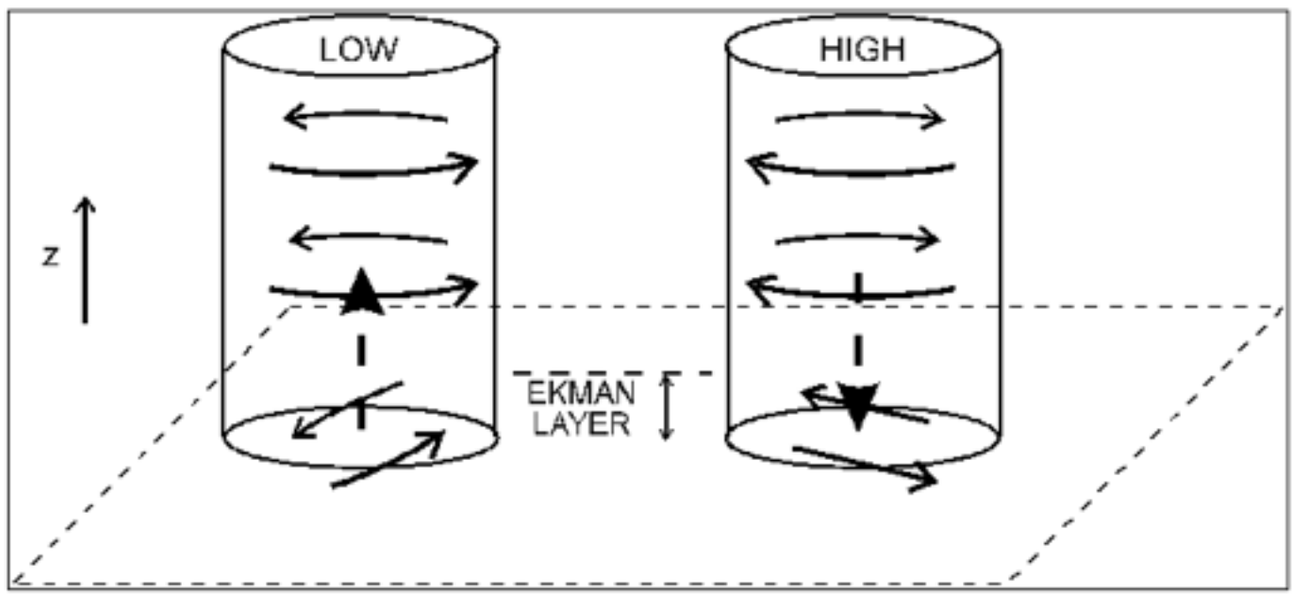
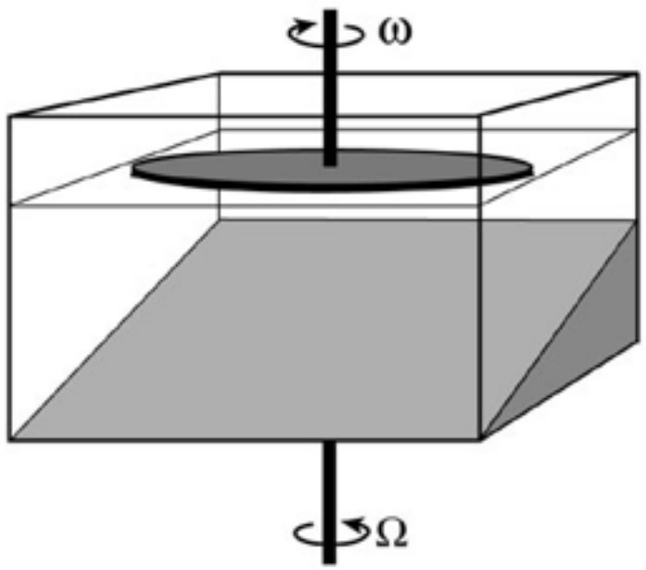
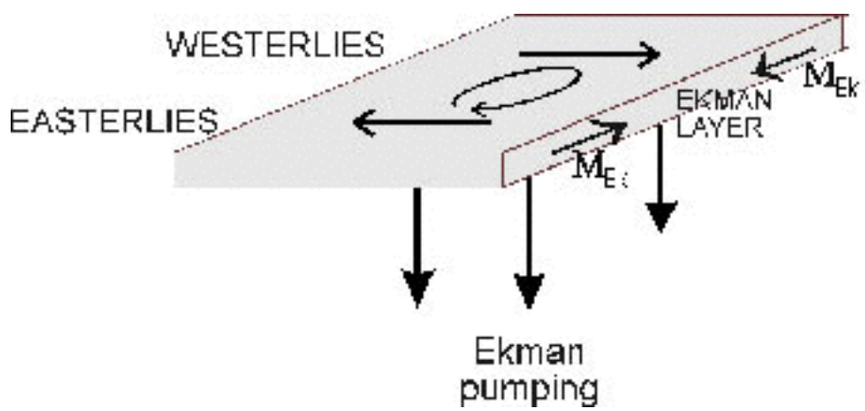
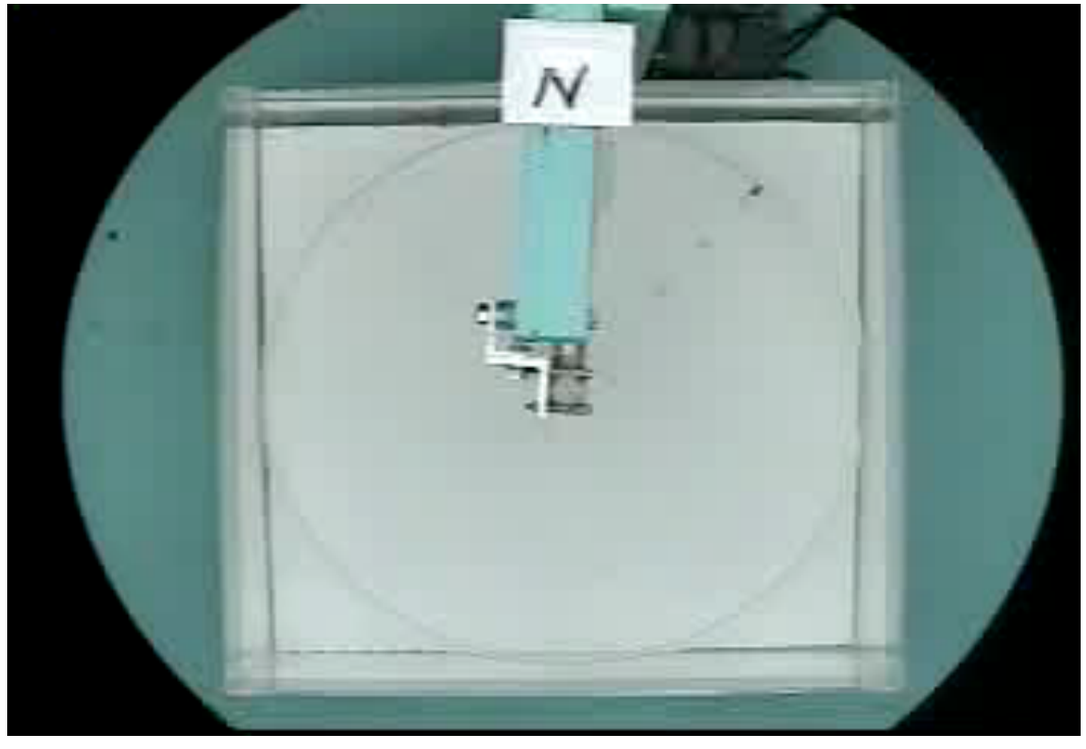


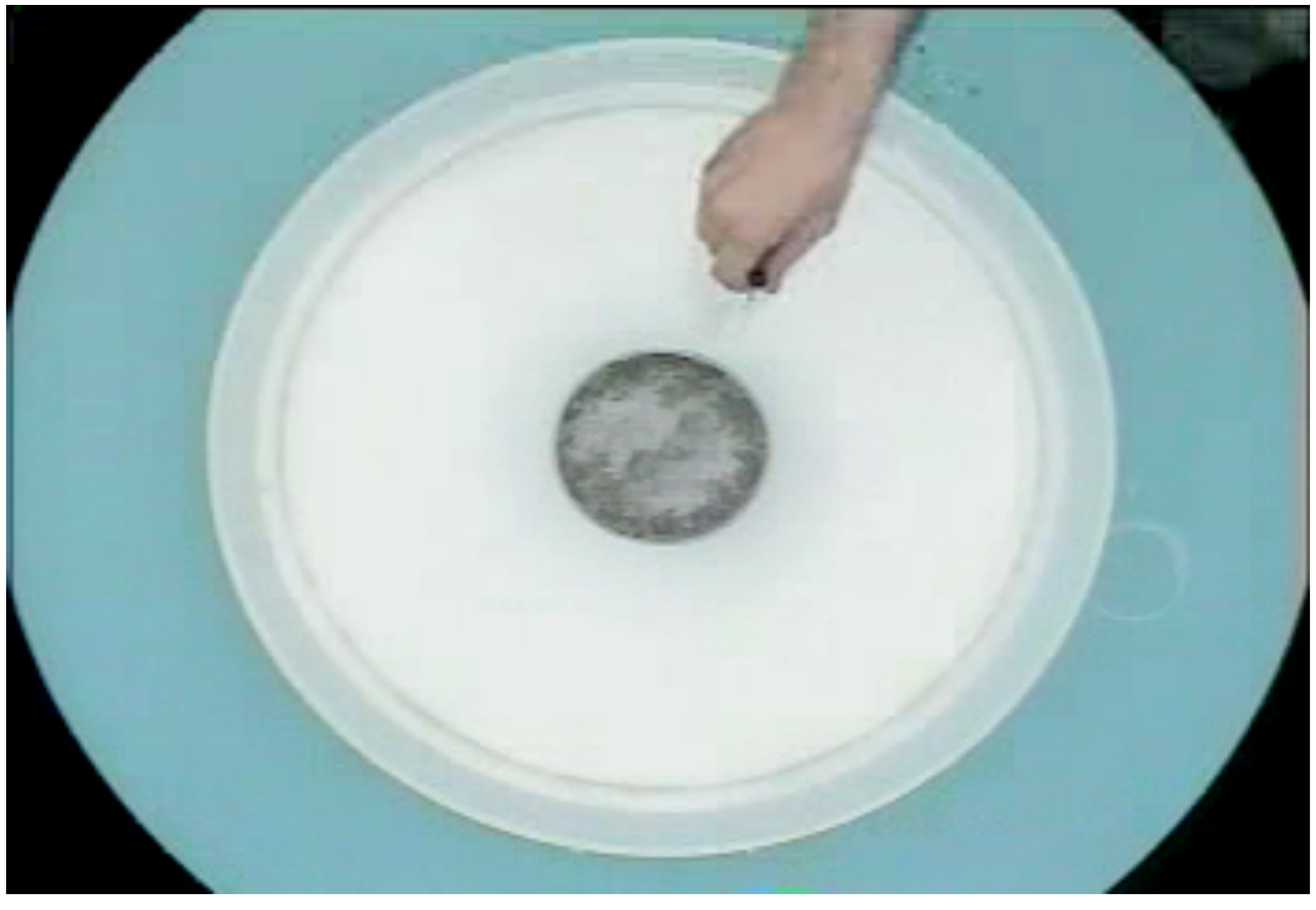
Wind-driven circulation

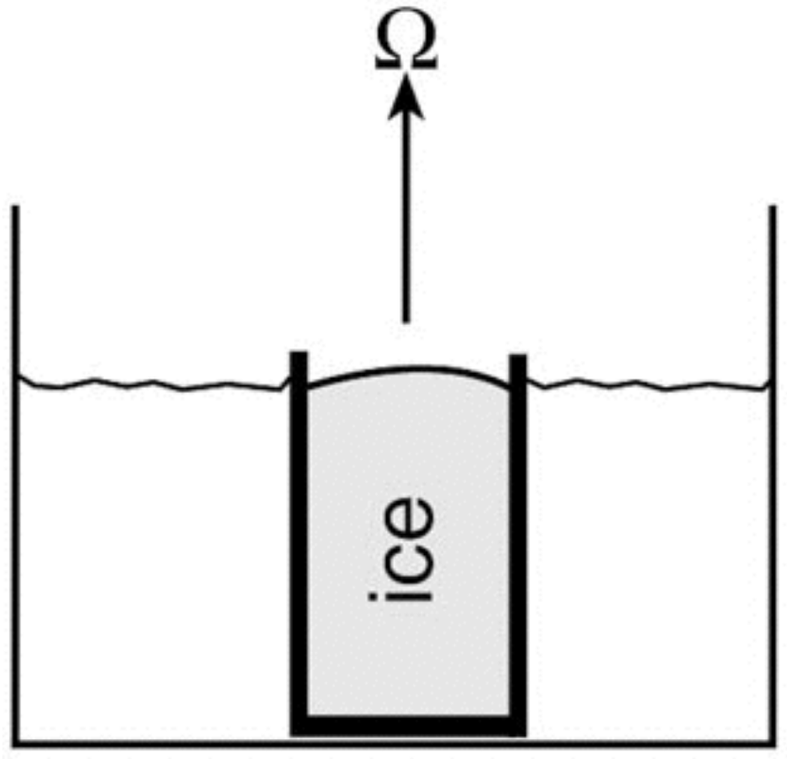






Atmospheric general circulation





Hadley circulation