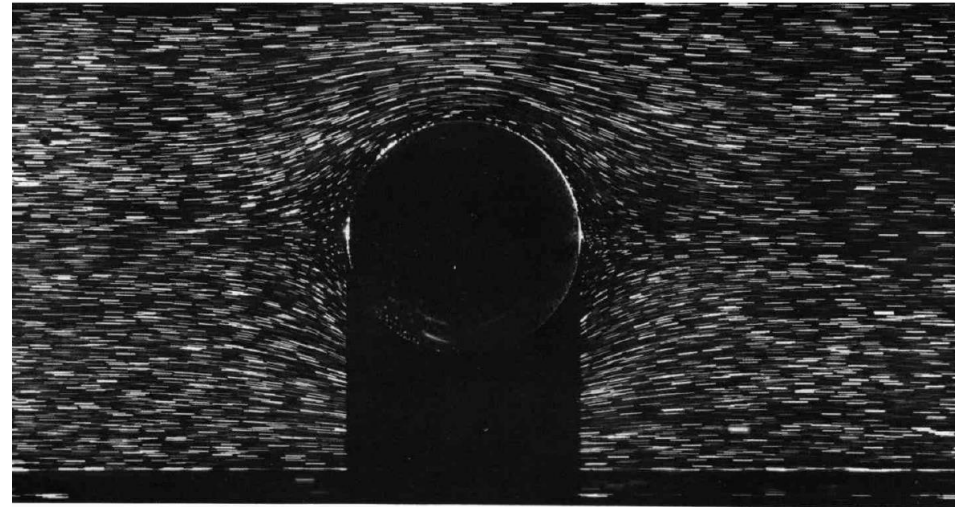


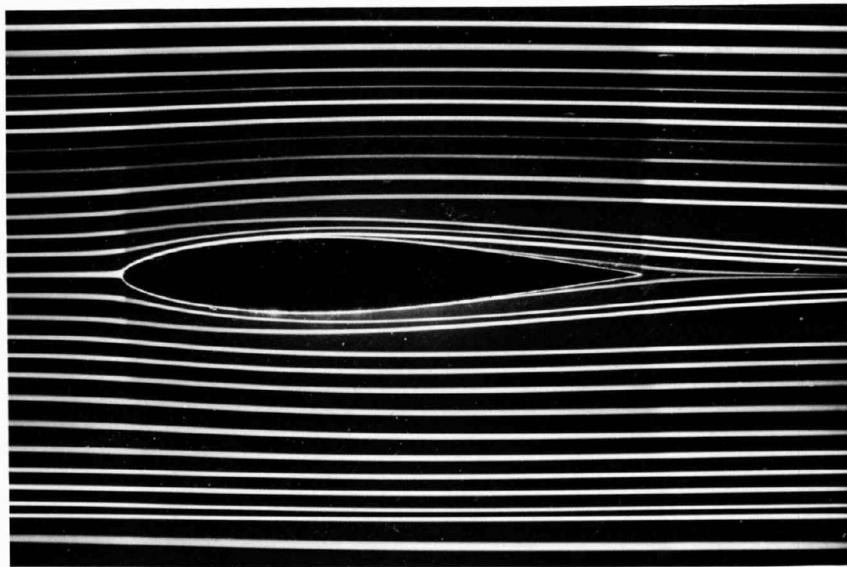
6. Uniform flow past a circular cylinder at $R=0.16$. That the flow is from left to right can scarcely be deduced from the streamline pattern, because in the limit of zero Reynolds number the flow past a solid body is reversible, and hence symmetric about a symmetric shape. It resem-

bles superficially the pattern of potential flow in figure 1, but the disturbances to the uniform stream die off much more slowly. The flow of water is shown by aluminum dust. Photograph by Sadatoshi Taneda



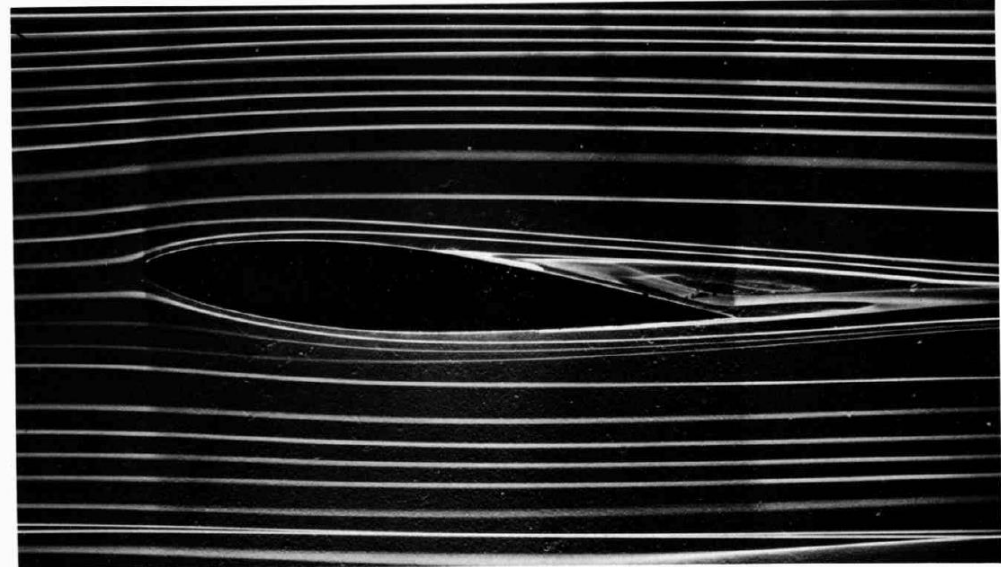
8. Sphere moving through a tube at $R=0.10$, relative motion. A free sphere is falling steadily down the axis of a tube of twice its diameter filled with glycerine. The camera is moved with the speed of the sphere to show the flow relative to it. The photograph has been rotated to show flow from left to right. Tiny magnesium cuttings are illuminated by a thin sheet of light, which casts a shadow of the sphere. Coutanceau 1968

ative to it. The photograph has been rotated to show flow from left to right. Tiny magnesium cuttings are illuminated by a thin sheet of light, which casts a shadow of the sphere. Coutanceau 1968



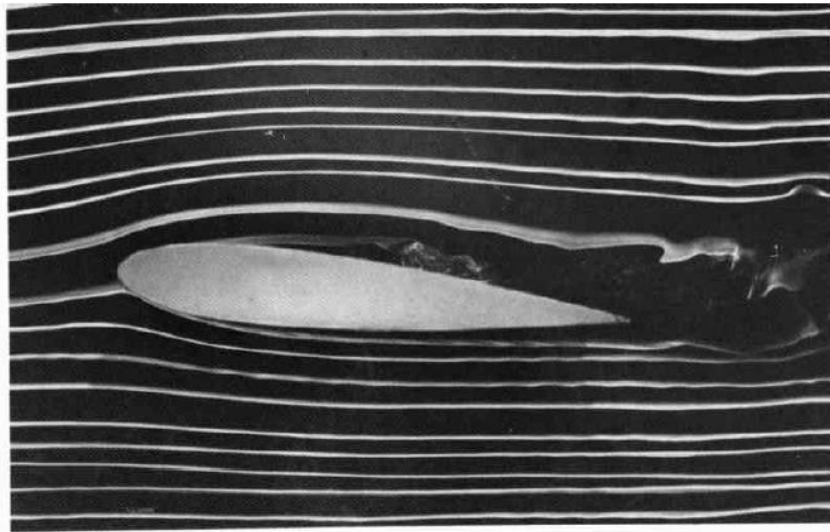
23. Symmetric plane flow past an airfoil. An NACA 64A015 profile is at zero incidence in a water tunnel. The Reynolds number is 7000 based on the chordlength. Streamlines are shown by colored fluid introduced up-

stream. The flow is evidently laminar and appears to be unseparated, though one might anticipate a small separated region near the trailing edge. ONERA photograph, Werlé 1974

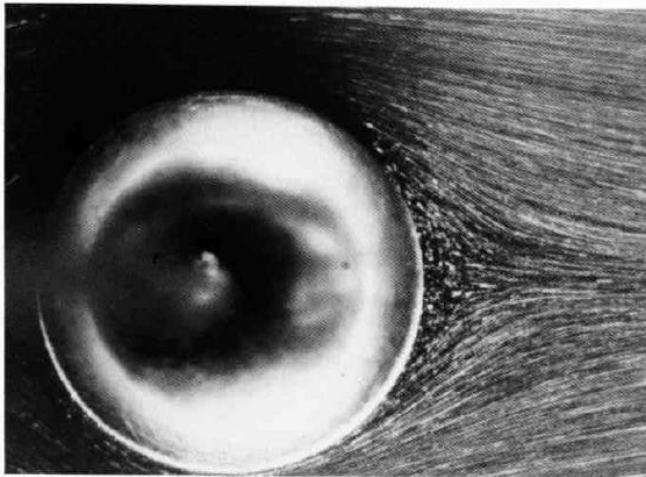


34. Boundary-layer separation on an inclined airfoil. When the NACA 64A015 airfoil of figure 23 is raised to 5° incidence the laminar boundary layer separates from the rear half of the upper surface. The flow remains attached

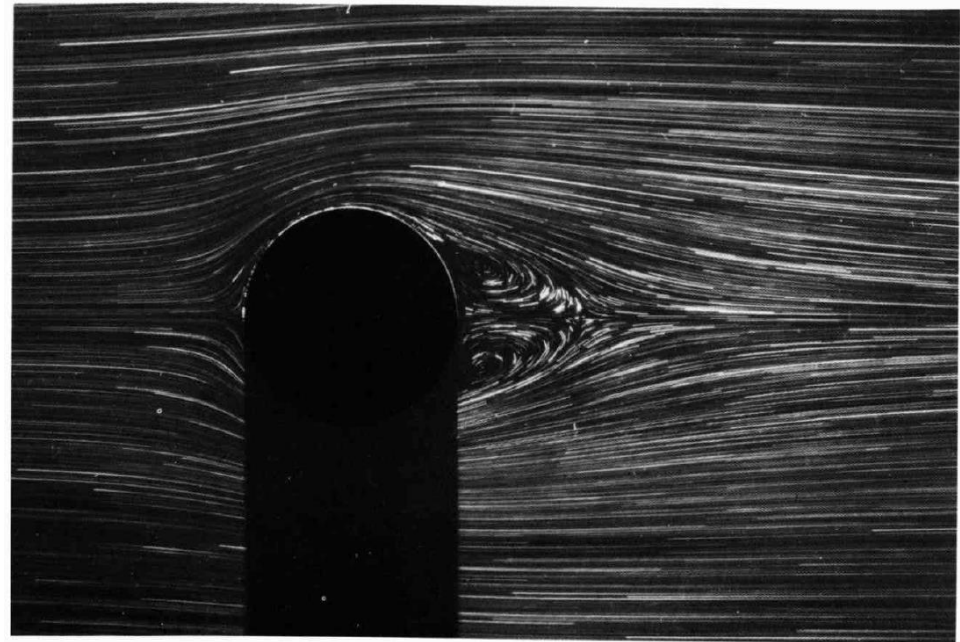
to the lower surface, from which it leaves tangentially at the trailing edge. Streamlines are shown by colored fluid filaments in water. ONERA photograph, Werlé 1974



72. Symmetrical airfoil at angle of attack. Smoke in a wind tunnel shows separation over the upper surface of a profile that is 15 per cent thick at 6° incidence and a Reynolds number of 20,000. Photograph by Peter Bradshaw



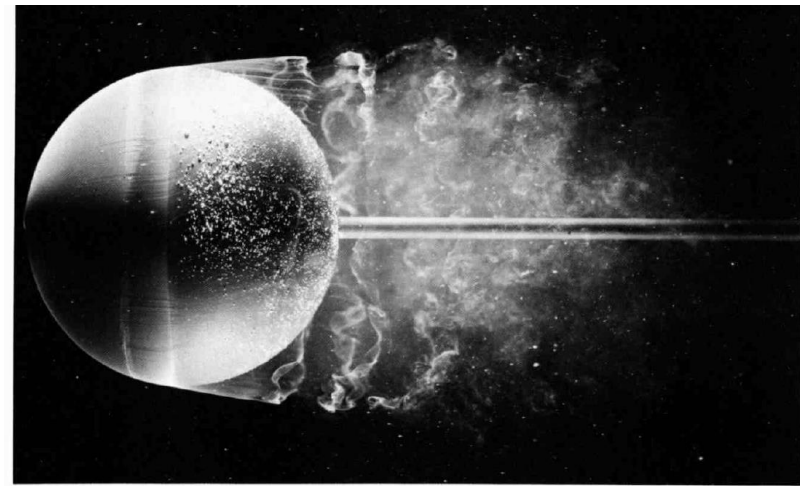
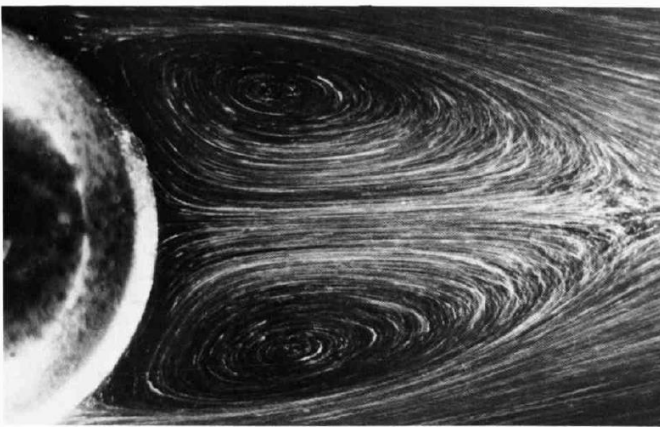
50. Sphere at $R=26.8$. At this slightly higher speed the flow has clearly separated over the rear of the sphere, to form a thin standing vortex ring. Aluminum dust is illuminated in water. Taneda 1956b



51. Sphere at $R=56.5$. As in figure 8, the sphere is falling steadily down the axis of a tube filled with oil, but here so large that the influence of the walls is negligible. Magnesium cuttings are illuminated by a sheet of light, which casts the shadow of the sphere. Archives de l'Académie des Sciences de Paris. Payard & Coutanceau 1974

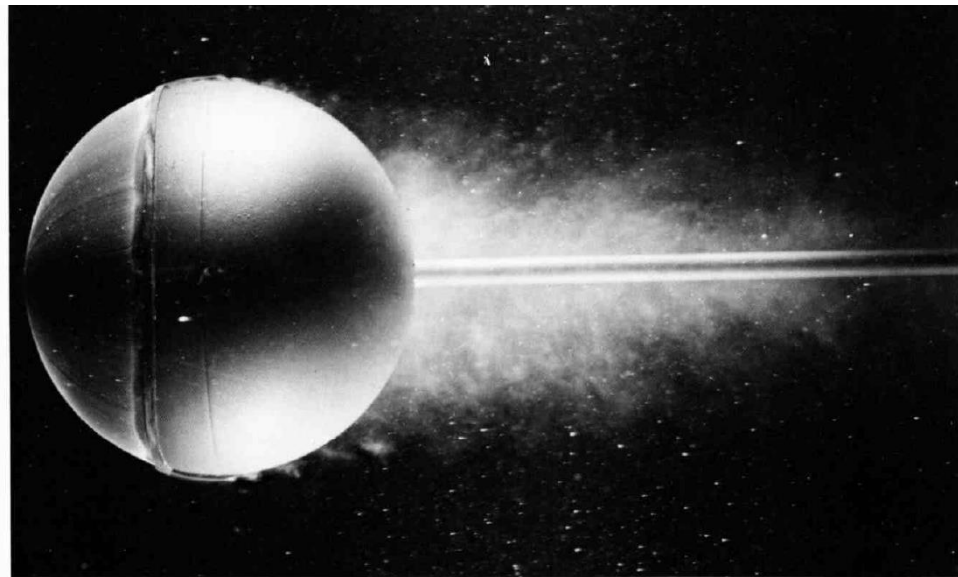
sium cuttings are illuminated by a sheet of light, which casts the shadow of the sphere. Archives de l'Académie des Sciences de Paris. Payard & Coutanceau 1974

53. Sphere at $R=118$. The wake grows more slowly in axisymmetric than plane flow. These photographs have shown that the length of the recirculating region is proportional to the logarithm of the Reynolds number, whereas it grows linearly with Reynolds number for a cylinder. Aluminum dust shows the flow of water. Taneda 1956b



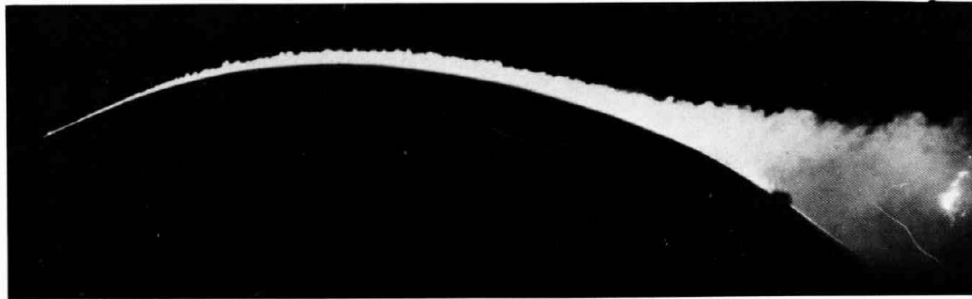
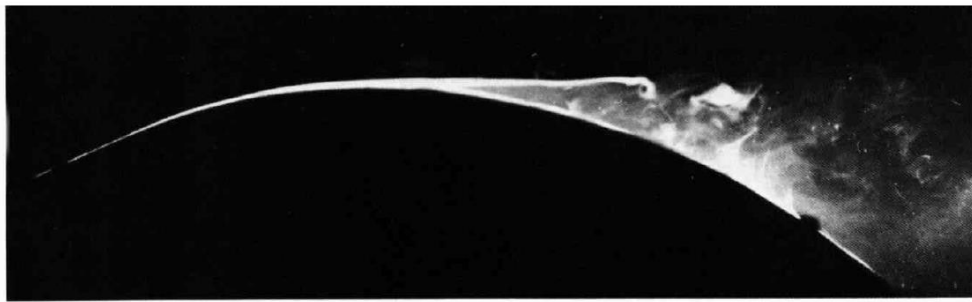
55. Instantaneous flow past a sphere at $R=15,000$. Dye in water shows a laminar boundary layer separating ahead of the equator and remaining laminar for almost one

radius. It then becomes unstable and quickly turns turbulent. ONERA photograph, Werlé 1980



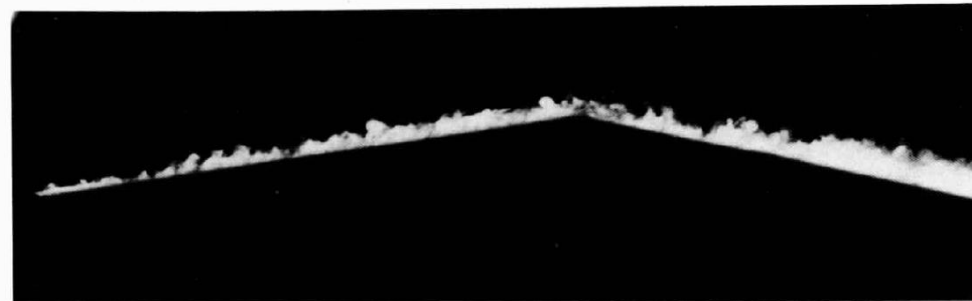
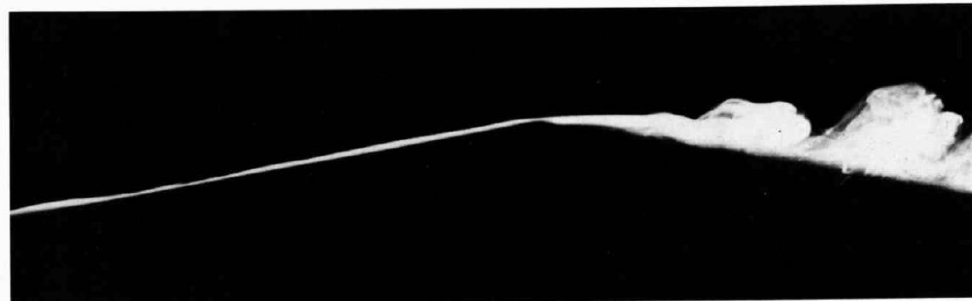
57. Instantaneous flow past a sphere at $R=30,000$ with a trip wire. A classical experiment of Prandtl and Wieselsberger is repeated here, using air bubbles in water. A wire hoop ahead of the equator trips the boundary layer. It becomes turbulent, so that it separates farther

rearward than if it were laminar (opposite page). The drag is thereby dramatically reduced, in a way that occurs naturally on a smooth sphere only at a Reynolds number ten times as great. ONERA photograph, Werlé 1980

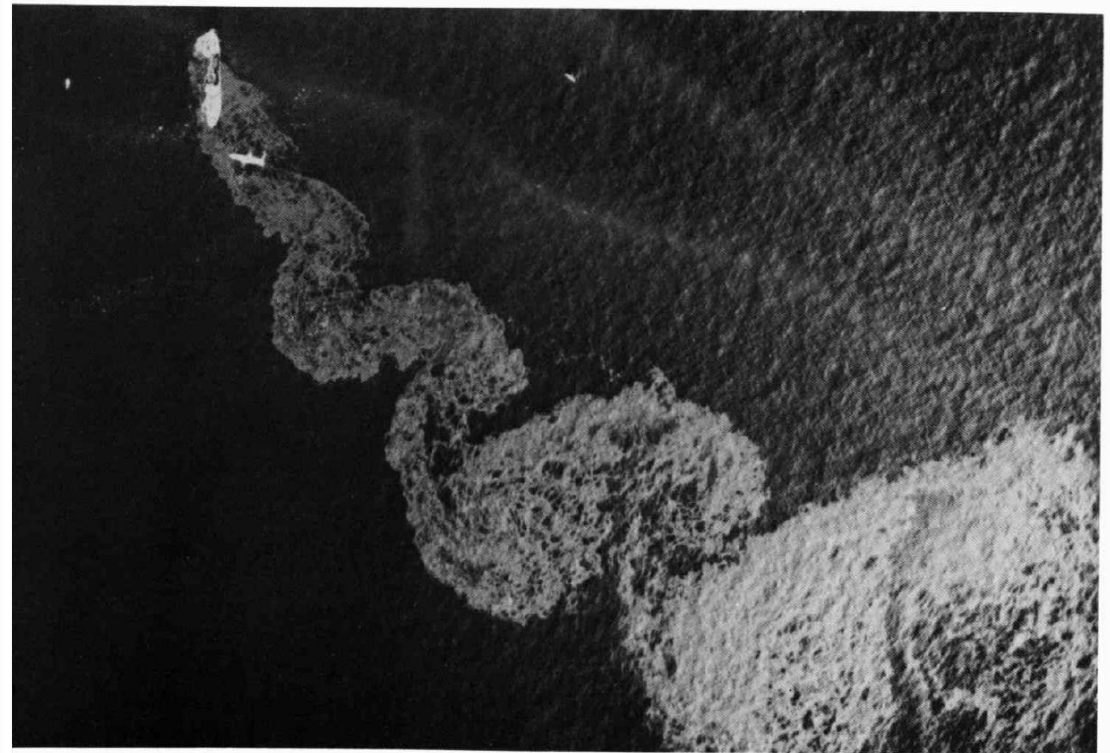


156. Comparison of laminar and turbulent boundary layers. The laminar boundary layer in the upper photograph separates from the crest of a convex surface (cf. figure 38), whereas the turbulent layer in the second

photograph remains attached; similar behavior is shown below for a sharp corner. (Cf. figures 55-58 for a sphere.) Titanium tetrachloride is painted on the forepart of the model in a wind tunnel. *Head 1982*



172. Wake of an inclined flat plate. The wake behind a plate at 45° angle of attack is turbulent at a Reynolds number of 4300. Aluminum flakes suspended in water show its characteristic sinuous form. *Cantwell 1981. Reproduced, with permission, from the Annual Review of Fluid Mechanics, Volume 13. © 1981 by Annual Reviews Inc.*



173. Wake of a grounded tankship. The tanker *Argo Merchant* went aground on the Nantucket shoals in 1976. Leaking crude oil shows that she happened to be inclined at about 45° to the current. Although the Reynolds

number is approximately 10^7 , the wake pattern is remarkably similar to that in the photograph at the top of the page. *NASA photograph, courtesy of O. M. Griffin, Naval Research Laboratory.*