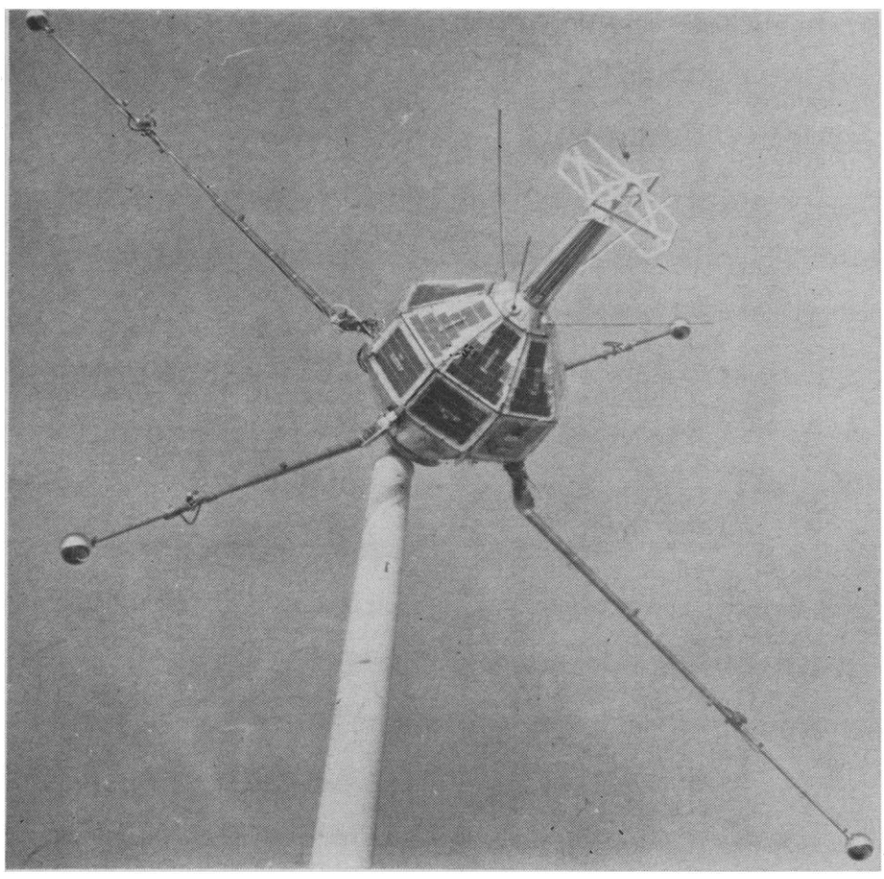
France in Space: Collaboration with Both U.S. and U.S.S.R.?

The French satellite FR-1, carrying instruments to study the ionosphere at very low radio frequencies transmitted from the ground, was sent into a near-polar orbit from California 6 December by a U.S. Scout rocket. At an altitude between 743 and 773 kilometers, well above the D, E, and F layers (50 to 600 kilometers) of the ionosphere, FR-1 is well placed for its intended studies of: (i) the very-low-frequency (VLF) field created in the magnetosphere by VLF waves from the earth's surface; (ii) ionospheric irregularities; (iii) the coefficient of transmission of the lower ionosphere; and (iv) wave propagation along force lines of the earth's magnetic field. Scientific leader for the FR-1 is L. R. O. Storey, who, during work for his doctorate at the University of Cambridge in the early 1950's, found that lightning flashes emit very-low-frequency signals which travel along the earth's lines of magnetic force and then are reflected back along them to near the point of origin, often many times.

Monitored and commanded by the U.S. National Aeronautics and Space Administration's world network of stations and also by the newly commissioned French stations in Africa (supplemented by a mobile station in Lebanon), the FR-1 receives broadcasts from Winkfield, England, Balboa, Panama Canal Zone, and other ground stations within the primary reception zone for VLF broadcasts or in the "conjugate" zone at the other end of the magnetic force lines emerging from the earth's surface near the VLF transmitter.



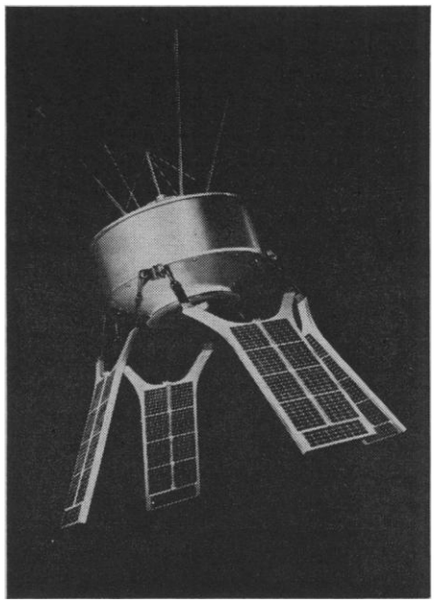
The French FR-1 satellite launched from California on 6 December 1965. [Centre National d'Etudes Spatiales]

The FR-1 was launched very soon after the launching of the A-1 vehicle, the first satellite to be sent into orbit by a French rocket, from Hammaguir in the Algerian Sahara 26 November. The A-1, a simple device designed to broadcast to the ground for a few weeks, was launched by the three-stage Diamant rocket in the first combined firing of all three stages. Separate stages had been tested as long ago as 1962, but the most extensive series of firings was in the spring and summer of 1965.

Now that the Diamant has proved itself, there is even more confidence in the success of its next task, the launching of a civilian-designed satellite, the D-1, scheduled for January. The D-1, weighing about 18 kilograms, is designed to orbit between 600 and 2900 kilometers and during about 3 months to carry out studies of the performance of its solar cells. For simple geodetic studies, the satellite will carry radios that will broadcast at 150 and 400 megacycles. Three complete payloads have been built.

The successful launches from the Sahara and from California illustrate the opportunities and limits faced by French space scientists: they have a rocket able to launch small payloads into low orbits; for larger payloads and greater distances, they must depend for many years on international collaboration.

It is likely that there will be other FR satellites launched in the United States, for there is great interest in France, not only in astronomical and geophysical experiments up to 200,000 kilometers from the earth, but also in a system of satellites which would obtain data from weather balloons traveling with high-altitude winds for many days at constant-pressure levels. This idea, much discussed in the United States at such laboratories as the National Center for Atmospheric Research in Boulder, Colorado, is called Project



The D-1 satellite, whose launching is scheduled for January 1966.

Eole in France, whose space agency, CNES, makes and launches balloons with capacities up to 50,000 cubic meters. Negotiations now going on between CNES and NASA may lead to an agreement to launch an FR satellite as part of the effort to develop the system of long-lived weather balloons monitored by satellites.

There are other factors pressing France toward greater emphasis on international collaboration. In 1967, for example, the agreement with Algeria for using Hammaguir expires. The rocket base France is building in Guiana may not be ready until 1969 because something like a budget stretch-out has been imposed on CNES. Even the 80-kilogram D-2 satellite, planned for measuring Lyman alpha radiation from the sun in 1968 or 1969, cannot be launched by current versions of the Diamant rocket (which did manage to send the 40-kilogram A-1 to an apogee of 2500 kilometers).

But even more important is the limitation on the heights to which French satellites can be launched by the rockets NASA can easily make available. The Scout can send probes out to 30,000 kilometers, but could not orbit a substantial satellite at that distance.

Hence there was warm, if somewhat skeptical, interest in France when, in October, a Soviet scientific delegation brought up the idea of launching French payloads on Soviet rockets. It appeared, according to the one authoritative account of this proposal (*Le Monde*, 11 November), that the Soviet scientists did not envisage French requests for precise knowledge about acceleration and vibration from Soviet rockets so that the payload design could proceed, nor did they expect that French scientists would wish to be present in Soviet launch-bases and tracking stations. Although the Soviet idea obviously reflected a sunny climate of relations between the Soviet Union and France (shown by such moves as the recent broadcast from the Soviet Molnya communications satellite to the French ground station at Plumeur Bodou), it was expected that the negotiations would be long and delicate. An important question, obviously, would be whether close collaboration with the Soviet Union would jeopardize the much-prized collaboration with the United States which is now bearing fruit.—VICTOR K. MCELHENY

Jacques Monod: Further Comments on French Universities

Since the announcement that Jacques Monod would share the 1965 Nobel prize in medicine, Monod has been using the attention that the award confers to spotlight inadequacies in the climate for research in French universities (see *Science*, 19 November). And he has not limited himself to historical or purely negative comments. In a recent interview in the journal of a national French union of university instructors, reprinted in *Le Monde* (23 November, p. 12), Monod argued for specific reforms, which, in some instances, would mean the adoption in French universities of measures worked out in the United States—for instance, comprehensive departments in preference to "single-professor" institutes, and postdoctoral fellowships to encourage movement from one laboratory to another.

In the interview, Monod outlined steps by which some important French scientists think their universities can revitalize the relationship between their teaching and their fast-developing fields of research. His views may be summarized as follows:

Although the period, after the *license* degree, of research leading to a thesis might be shorter than it is now, that is, no longer than 4 to 5 years, one should reject radical urgings that the thesis be replaced by a collection of related short papers. Editing a thesis, which signifies acquisition of mastery, comprehension, discipline, method, and above all the ability to make discoveries, is a necessary, important experience for a future Ph.D.

The studies leading to the *agrégation* degree are artificial and focused on secondary education and hence are of little use for training university instructors who must also be researchers. The development of biology in France has been disastrously affected by the *agrégation*.

Much more useful would be the postdoctoral fellowship, an American institution, which is still very unusual in France. Such fellowships, which require that the holder move to a laboratory other than the one in which he earned his doctorate and that he work on topics different from that of his thesis, constitute a period of going more deeply and of gaining contact with other methodologies in the same discipline. The American pattern of 4 years of thesis preparation followed by several more years of postdoctoral enrichment seems a good scheme for training men who can teach and carry out their own research.

The opposition to creating departments in faculties of sciences probably originates from a fear of restoring a monolithic structure in various fields or of reviving a kind of academic dictatorship. But the real purpose of a department is to organize and share the instruction, not research. Research should be left to small teams, an arrangement which granting agencies should favor. Department chairmen would be chosen in rotation to serve for fixed terms. Such departmental organization would seem indispensable for running large faculties—like those of Paris, which now have no organization at all.

Multiple sources of research funds would be a further safeguard against a dictatorship in monolithic departments. "One must have disorder in the administration of research," he said.—V.K.M.