

Astronomers' Universe

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Pierre Léna

Racing the Moon's Shadow with Concorde 001

 Springer

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Cover illustration and Frontispiece: Racing the Moon by Don Connolly, Sydenham, Ontario, Canada. Conception by L. Robert Morris, Ottawa, Canada. Composition by Don Connolly and L. Robert Morris. Acrylic on board (49x68 cm), 2004. This artist view is done with the assumption that the viewer is located 3,000 m below the aircraft, at latitude 16.19°N, longitude 14.38°E, altitude of Concorde 001 17,602 m above Niger, time : 12h 07 min 24 s UTC.

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*I dedicate the English translation of this book
to the young students of Ross School, where
they happily discover the beauty of science,
the richness of human cultures, and how best
to serve their sisters and brothers, inhabitants
of our planet*

Acknowledgements

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¹ The *Fondation des Treilles* was set up by Anne Gruner-Schlumberger with the aim of encouraging a dialogue between science and the arts and hence to stimulate progress in contemporary research and creativity. It hosts researchers and writers at the *Domaine des Treilles* in the Var region of France: <http://www.les-treilles.com>

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Overture

[...] *mon luth constellé*
Porte le Soleil noir [...]
Gérard de Nerval²

On that 30 June 1973, the summer Sun rose over Las Palmas, the capital of the Canary Islands off the African coast, but this time there was something different in its appearance. A piece of the solar disk was missing, blacked out by the edge of the Moon, for our satellite had just begun to move between the Sun and the Earth. At sunrise on the same day, far to the west in Dutch Guiana (now Surinam), the tree frogs of the species *Hyla calcarata* began to chorus, despite the unusual time of day.³ For indeed it was there on the equator that the great dark disk formed by the Moon's shadow on the surface of the Earth, surrounded by penumbra, began its race towards the east, moving at a speed of more than 2000 km an hour relative to the ground, soon to cross the African coastline. Astronomers, who know how to predict not just the occurrence, but all the details of these eclipses, had explained how this one would be total at every point on the Earth that the shadow would sweep past and partial in each region falling only in the penumbra. Better still, in Africa, total obscurity would last, exceptionally, for 7 min, and the sky would be so dark that the stars would be visible even at midday. This record length would make it the eclipse of the century, as announced by the media. By around 10 o'clock in the morning, the black indentation had grown to block out almost half of the Sun's disk. Slowly, a great white bird began to move across the tarmac at Las Palmas airport to position itself on the runway. Fitted out with a bright red survival suit—standard dress for test flight crew members, in case they need to be fished out of the sea—I found myself aboard Concorde 001F-WTSS, the prototype of the future supersonic

² [...] *and my constellated lute*
Bears the black Sun [...]

³ Jean Lescuré: *Comportement vocal des amphibiens et des oiseaux au Surinam*. In: *Soleil est mort: l'éclipse totale du 30 juin 1973*, G. Francillon & P. Menget (eds), pp. 91–103 (1979). See the bibliography.

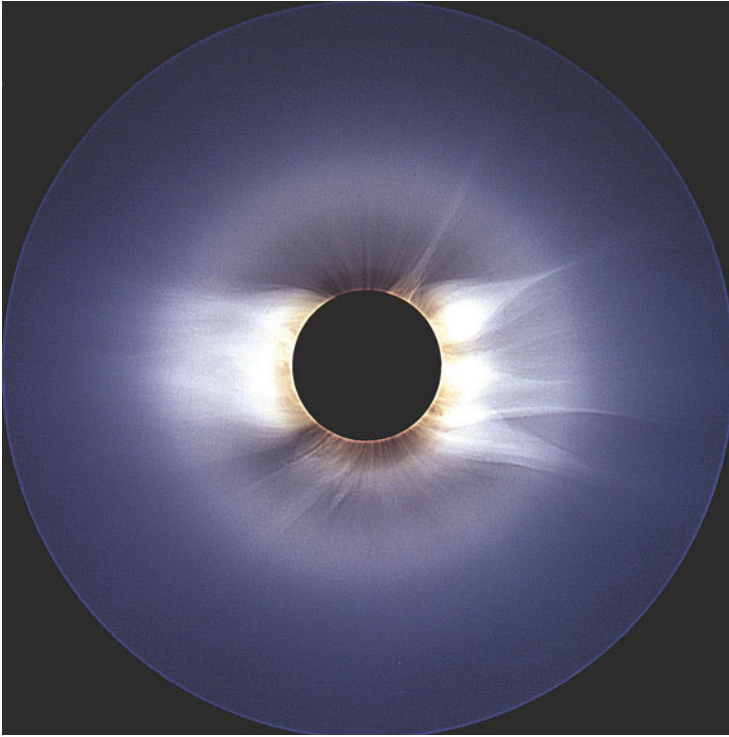


Fig. 1 The solar corona, photographed by Serge Koutchmy from Moussoro in Chad during the total eclipse of 30 June 1973. The observer is in the umbra (*full shadow*), 100 km *south* of the line of centrality. © Institut d’astrophysique de Paris/CNRS

passenger aircraft to be flown by Air France and British Airways, with seven other astronomers. At the controls, André Turcat, the famous pilot who had directed all the test flights of this plane since 1969, and Jean Dabos both kitted out with the same survival gear. The four other men making up the crew were ready at their posts: “Sierra Sierra, ready for takeoff”, announced the control tower. Exactly on time within a second, the beautiful aircraft took off into the trade winds, accompanied by the roar of its four jet engines, flying to meet the shadow of the Moon somewhere above the barren deserts of Mauritania. Less than an hour later, having accelerated to more than twice the speed of sound in the stratosphere, to which it rises in order to attain its cruising altitude, Concorde 001 was about to encounter the Moon’s shadow at precisely the place and time identified by our calculations. The accuracy of the rendezvous was extraordinary, since we reached it within 1 s and at less than 2 km from the ideal point. The plane’s night-time navigation lights went on even though it was close to midday local time and the Sun was close to our zenith. Flying in the lunar shadow, which was moving at the same speed as us, the

plane would remain in total darkness for 74 very long minutes, while each of the astronomers was getting busy with the instruments they had brought along to study the Sun and its corona, taking advantage of this unique opportunity to observe for such a long period of time. When we landed at Fort Lamy, today N'Djamena, the capital of Chad in the very heart of the African continent, I was filled with emotion. This dream which, as a young astrophysicist and teacher, I had sketched out barely a year earlier had just been made a reality. No man had ever seen the Sun eclipsed for such a long time, no flight crew had ever carried out such a difficult encounter so faultlessly, no plane had ever provided such a fine observatory for its team of awestruck astronomers. Forty years on, this record remains unbeaten.



Fig. 2 The shadow of the Moon on the Earth, surrounded by the penumbra. The photograph was taken from space by the French astronaut Jean-Pierre Haigneré on board the Mir space station during the total eclipse of the Sun of 10 August 1999, which was visible in France. © CNES/JP Haigneré, 1999

In the Mauritanian sky, as Tuaregs gazed astonished upon this Sun so quick to hide, three parallel stories would finally come together. The first began with humanity which, in all its cultures, had long feared the total eclipse of the Sun, but then sought to understand its cause, and finally to use it scientifically to study the celestial body which brings us light, heat, and life. The second story concerns the extraordinary aircraft that was Concorde, and for which 001 was the first prototype, flying since 1969 and based in Toulouse. So how was this plane deflected from its main objective, that is, the flight tests of a future supersonic passenger plane, to become a scientific laboratory chasing after the shadow of the Moon? Finally, the third story concerns me more directly, since it took me years to become

a research scientist, to discover my interest for the Sun and infrared light, to learn the difficult techniques required to fly telescopes aboard aircraft, to build a team that could accompany me in this project, and to dream up this African flight and turn it into a reality.



Fig. 3 At 10 h 08 Universal Time on 30 June 1973, the prototype Concorde 001, registration F-WTSS, took off from Las Palmas airport in the Canary Islands to meet up, somewhere over West Africa, with the Moon's shadow, already slipping rapidly over the Earth's surface. The afterburn (or reheat) of the four engines has been activated to get the 136 tonne airliner off the ground. © Jim Lesurf

This is the encounter that I would like to narrate, and it is a true story. The telescopes and the Sun, the supersonic aircraft chasing the shadow, the astronomers, the engineers, and the pilots who set this exceptional record really did exist. This was no video game in which the player travels at will through space and time, nor a comic strip with something fantastical in every picture. It was a collective human adventure which we really experienced. Here I wish to transmit this tale to those who lived through those times, but also to the younger generation in the hope of kindling other dreams and helping them to confront the hard realities of life. I would so much like to encourage them to aim high and excel themselves in new adventures, fulfilling those dreams. But I do have one regret, for my female readers. There are so few women in this story: astronomers, engineers, and crew were all men, and there is nothing I can do about that. However, during my working life, I have had brilliant female colleagues, an honour to astrophysics, and many of my former students have acquired international acclaim, such as Nabila Aghanim, whom I met in Algiers many years ago, now exploring the depths of the past universe. Aviation also has its heroines, such as Commander Caroline Aigle, former student at the *Polytechnique*, later fighter pilot, who sadly passed away in 2007, or Catherine Maunoury, twice winner of the World Aerobatic Championships and today director of the *Musée de l'Air et de l'Espace* in Le Bourget (France), which has housed Concorde 001 since 1973. And not forgetting space, with Claudie Haigneré, a doctor who decided to become an astronaut and spent a total of more than

25 days in space during her various missions. Women are as much needed in science as in exploits of bravery and intellect.

Many glorious and fruitful projects have marked the twentieth century, such as those undertaken by the men and women who went into space, and in particular the Apollo missions to the Moon. They mobilised so many more people, and much greater resources and intelligence than our modest eclipse expedition, and they brought back immeasurably greater scientific results. However, in my own adventure, astronomy and aviation came together in a quite exceptional, and perhaps unique, way that may not be rivalled for some time to come. So I feel the story deserves to be told.

But why did I wait 40 years for this? After Concorde, my existence was occupied by so many other astronomy projects, leaving me little time to look back. Today, before all those involved should pass away, it seems the right moment to recount all this to the younger generation.

NOTE: The reader will find several supplementary explanations of a scientific nature in appendix at the end of the book, but these are not essential to follow the story.