We have reached the core of the problem. "What is time?" Must we accept the opposition, traditional since Kant, between the static time of classical physics and the existential time we experience in our lives? According to Carnap:

> Once Einstein said that the problem of the Now worried him seriously. He explained that the experience of the Now means something special for man, something essentially different from the past and the future, but that this important difference does not and cannot occur within physics. That this experience cannot be grasped by science seemed to him a matter of painful but inevitable resignation. I remarked that all that occurs objectively can be described in science; on the one hand the temporal sequence of events is described in physics; and, on the other hand, the peculiarities of man's experiences with respect to time, including his different attitude towards past, present and future, can be described and (in principle) explained in psychology. But Einstein thought that these scientific descriptions cannot possibly satisfy our human needs; that there is something essential about the Now which is just outside of the realm of science.[2]

It is interesting to note that Bergson, in a sense following an opposite road, also reached a dualistic conclusion (see Chapter III). Like Einstein, Bergson started with a subjective time and then moved to time in nature, time as objectified by physics. However, for him this objectivization led to a debasement of time. Internal existential time has qualitative features that are lost in the process. It is for this reason that Bergson introduced the distinction between physical time and duration, a concept referring to existential time.

But we cannot stop here. As J. T. Fraser says, "The resulting dichotomy between time felt and time understood is a hallmark of scientific-industrial civilization, a sort of collective schizophrenia."[3] As we have already emphasized, where classical science used to emphasize permanence, we now find change and evolution; we no longer see in the skies the trajectories that filled Kant's heart with the same admiration as the moral law residing in him. We now see strange objects: quasars, pulsars, galaxies exploding and being torn apart, stars

that, we are told, collapse into "black holes" irreversibly devouring everything they manage to ensnare.

Time has penetrated not only biology, geology, and the social sciences but also the two levels from which it has been traditionally excluded, the microscopic and the cosmic. Not only life, but also the universe as a whole has a history; this has profound implications.

The first theoretical paper dealing with a cosmological model from the point of view of general relativity was published by Einstein in 1917. It presented a static, timeless view of the universe, Spinoza's vision translated into physics. But then comes the unexpected. It became immediately evident that there were other, time-dependent solutions to Einstein's cosmological equations. We owe this discovery to the Russian astrophysicist A. Friedmann and the Belgian G. Lemaître. At the same time Hubble and his coworkers were studying the motions of galaxies, and they demonstrated that the velocity of distant galaxies is proportional to their distance from earth. The relation with the expanding universe discovered by Friedmann and Lemaître was obvious. Yet for many years physicists remained reluctant to accept such an "historical" description of cosmic evolution. Einstein himself was wary of it. Lemaître often said that when he tried to discuss with Einstein the possibility of making the initial state of the universe more precise and perhaps finding there the explanation of cosmic rays, Einstein showed no interest.

The Rise of Quantum Mechanics

Relativity altered the classical concept of objectivity. However, it left unchanged another fundamental characteristic of classical physics, namely, the ambition to achieve a "complete" description of nature. After relativity, physicists could no longer appeal to a demon who observed the entire universe from outside, but they could still conceive of a supreme mathematician who, as Einstein claimed, neither cheats nor plays dice. This mathematician would possess the formula of the universe, which would include a complete description of nature. In this sense, relativity remains a continuation of classical physics.

1.
Order out of Chaos: The Evolutionary Paradigm and the Physical Sciences

by Ilya Prigogine and Isabelle Stengers

BL But doesn't this suppose another temporality, a nonmodern way of considering the passage of time?

MS This is truly the fundamental question. Whether it's the scientific hypothesis, on the one hand, which we have called the hypothesis of excellence, or, on the other hand, that of historicism, the two suppose that time develops in a linear fashion—that is, that there really is an enormous distance, more than a score of centuries, between Lucretius and today's physics. Whether this time is cumulative, continuous, or interrupted, it always remains linear.

BL Because of succession. Or successions of revolutions, as described by the epistemologists or even Foucault.

MS There you are. But time is in reality somewhat more complicated than that. You no doubt are familiar with chaos theory, which says that disorder occurring in nature can be explained, or reordered, by means of fractal attractors.

BL Yes. According to this, chance is nonetheless determined, and disorder is produced by an underlying order.

MS Exactly. But in this, order as such is harder to perceive, and customary determinism has a slightly different appearance. Time does not always flow according to a line (my first intuition of this is in my book on Leibniz [284–86]) nor according to a plan but, rather, according to an extraordinarily complex mixture, as though it reflected stopping points, ruptures, deep wells, chimneys of thunderous acceleration, rendings, gaps—all sown at random, at least in a visible disorder. Thus, the development of history truly resembles what chaos theory describes. Once you understand this, it's not hard to accept the fact that time doesn't always develop according to a line and thus things that are very close can exist in culture, but the line makes them appear very distant from one another. Or, on the other hand, that there are things that seem very close that, in fact, are very distant from one another. Lucretius and modern theory of fluids are considered as two places separated by an immense distance, whereas I see them as in the same neighborhood.

In order to explain these two perceptions we must, in fact, clarify the theory of time. The classical theory is that of the line, continuous or interrupted, while mine would be more chaotic. Time flows in an extraordinarily complex, unexpected, complicated way . . .

BL So, it is not you who travel through time but, rather, the elements that become close in this chaotic time?

MS Certainly. Time is paradoxical; it folds or twists; it is as various as the dance of flames in a brazier—here interrupted, there vertical, mobile, and unexpected.

The French language in its wisdom uses the same word for weather and time, *le temps*. At a profound level they are the same thing. Meteorological weather, predictable and unpredictable, will no doubt some day be explainable by complicated notions of fluctuations, strange attractors. . . . Someday we will perhaps understand that historical time is even more complicated.

BL In any case, it doesn't "pass."

MS Yes, it passes, and also it doesn't pass. We must bring the word *pass* closer to *passoir*—"sieve." Time doesn't flow; it percolates. This means precisely that it passes and doesn't pass. I'm very fond of the theory of percolation, which tells us things that are evident, concrete, decisive, and new about space and time.

In Latin the verb *colare*, the origin of the French verb *couler*, "to flow," means precisely "to filter." In a filter one flux passes through, while another does not.

BL But it doesn't pass in the form of a fluid. It's not a fluid.

2. Conversations on Science, Culture, and Time

MICHEL SERRES with BRUNO LATOUR