undulator, a complicated magnetic structure like the one used in the FEL or free electron laser. So I got the very simple idea of using the single frequency that you have in the FEL to do that, and I believe that idea works out.

Of course, I have not been able to work out all the specifics yet. A superconductor, even from a conceptual point of view, is a very complicated system. There's the question of pair condensation and so forth, but these are just technicalities. Again, the concept is that when a particle moves on a magnetic structure that undulates, then it works with a single frequency. That is the frequency in which the electrons can talk to each other, get ordered, and condense.

This is a dynamic order, not a static order. These are relationships not in space but in time. This is because you want to have at the same time order and plasticity. You don't want this order to be frozen; you want this order to move like water and yet keep its formation even though it moves.

Superradiance is an ordering that comes from the fact that the matter systems—say, electrons, atoms, molecules, nuclei, whatever—communicate with each other in particular frequencies of the electromagnetic field. It is a superradiating process because the radiation is enormously amplified by the fact that there are many systems that radiate precisely, the same way it happens in a laser.

Q: You have also proposed that this behavior of condensed matter can explain some peculiar properties of water that may play a part in the observed water with "memory" of the Benveniste experiment?

Preparata: Here a similar thing could be happening, only with different actors in the play, shall we say. But these actors tend to play always in the same way (see box).

Q: How did you arrive at the notion of superradiance?

Preparata: Throughout my life I concentrated on quarks, on the behavior of matter at very deep layers where there are still frontiers. It is not an area where the laws are yet established, so you still struggle to understand what the forces are, what the fields are, and how they behave. It is not like ordinary matter, where scientists know precisely what the forces and the actors of the collective drama of matter are. For some reason, because of certain steps I took in my life, I was able to transfer to this area the things I had understood for quarks. About three years ago, by chance I got interested in this area. Putting two and two together, a picture of matter emerged that made a tremendous amount of sense.

How H_2O molecules can 'communicate'

Giuliano Preparata discusses a potential explanation for the Benveniste experiment in Paris in 1988, in which water seemed to have a "memory." His remarks are condensed from an article he wrote for the Italian daily La Stampa, *in August 1988.*

I would like to present a few recent theoretical developments on the structure of water that, far from explaining the results of the Benveniste group, do, however, shed light on the capacity of water, up to now unknown, to organize itself around biological molecules in dynamic structures of considerable complexity. It allows for phenomena that imply that water assumes an active role in biological reactions. . . .

Some months ago, my colleagues, E. Del Giudice and G. Vitiello, and I decided to apply some ideas that I had developed in the area of laser physics, to the fundamental substrate of living material: water. We decided to concentrate on the most simple aspects of water. We described it as a collection of a large number of molecules in the shape of a wide "V," with oxygen at the vertex and the two hydrogen atoms at the ends. These rotate without stop, trailing behind them a sort of radio antenna because of asymmetry of the electric charges of the atoms of hydrogen (positive) and of the oxygen atoms (negative).

Soon it became clear to me that this rotating antenna created a communication of the molecules via "radio" within a distance of some tens of microns, the typical dimension of the cell. This radio contact informs the molecules to combine together at precise cadences, transforming the initial chaos into a dynamic order, very similar to what happens to the photons in a laser.

Water, in fact, behaves like a laser! In the "preordered" system of this myriad of walky-talkies that are constantly exchanging information, we attempt now to place a biological molecule also equipped with a walky-talky (which is usually the case). This new molecule will be able to "give orders" to the water around it at a distance equal to that of the cell's dimensions, generating in this way around itself a state of water that is very "personalized," that depends on the type of "orders" that were given.

That molecules of water could communicate electromagnetically on particular frequencies has been known for a long time. It used to be thought, though, that the signals were too weak to have appreciable consequences. What has been understood recently is that, due to a mechanism that occurs also in lasers, the mechanics of quanta enormously amplifies these signals.