decreasing temperature, tending towards a finite or even zero value at zero temperature.

How does this fit in with theory? A few months ago, Dobrosavljevíc and co-workers[7] showed that scaling theory allows only two possibilities for the zero-temperature behaviour: either infinite resistance or infinite conductance (the latter caused by a many-body effect arising from the Coulomb interaction between the electrons). If this is true, the transition observed in experiments must be from perfectly conducting to perfectly insulating.

This picture is reinforced by the new study on the effect of a parallel magnetic field. Simonian and collaborators[3] found that an external field of more than one tesla, applied in the plane of the sample, suppressed the metallic state completely. Such coplanar fields only polarize the spins of the electrons, which at higher temperatures and in ordinary metals does not lead to any drastic change in conductance. So the spin state is central to the high conductance of the metallic state — a characteristic of superconductors. In fact, Finkel'shtein[5] and others[8] showed that the interaction effects can be reliably treated for spin-polarized electrons, and predicted that only an insulating ground state is possible in this case.

Why might the metallic state be a perfect conductor at zero temperature? Is it just a standard superconductor, perhaps with an unusual internal symmetry[9]? Or is it a more unusual superconductor driven by a combined disorder and interaction effect[10]? Another exciting possibility is a form of superconductor with broken time-reversal symmetry, which would optimize the inter-electron correlation and so perhaps be stabilized by Coulomb interactions[11].

Further experiments will be a big help here. For example, by going to temperatures much lower than the present limit of 0.1 K, we can test the hypothesis of perfect conductance, and look for a finite-temperature superconducting phase transition. For now, this apparently simple system of a two-dimensional electron fluid moving in a weak random potential still poses some basic challenges to our understanding. □

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Palaeontology

Deep roots for the Neanderthals

G. Philip Rightmire

Since their bones were first discovered in the last century, the inventory of Neanderthals from Europe has grown substantially. These people are known from caves and rock shelters of the Late Pleistocene (130,000 years ago), and their anatomy has been described in detail. Older fossils that seem to predict the specialized Neanderthal morphology are also on record, and this lineage can be traced back in time for almost 200,000 years. What happened earlier is less clear, because fewer bones have been available for study. But this situation has now changed — since the mid-1980s, palaeontologists investigating an ancient cave near Burgos in northern Spain have uncovered a remarkable cache of human fossils. This assemblage from the Sima de los Huesos ('Pit of Bones') includes several well-preserved crania, along with jaws, teeth and other body parts of at least 32 individuals. The site and its contents are described by Juan-Luis Arsuaga and his colleagues[1] in the *Journal of Human Evolution*, and the finds reveal much about the people who preceded the Neanderthals, and the course of human evolution in the Middle Pleistocene.

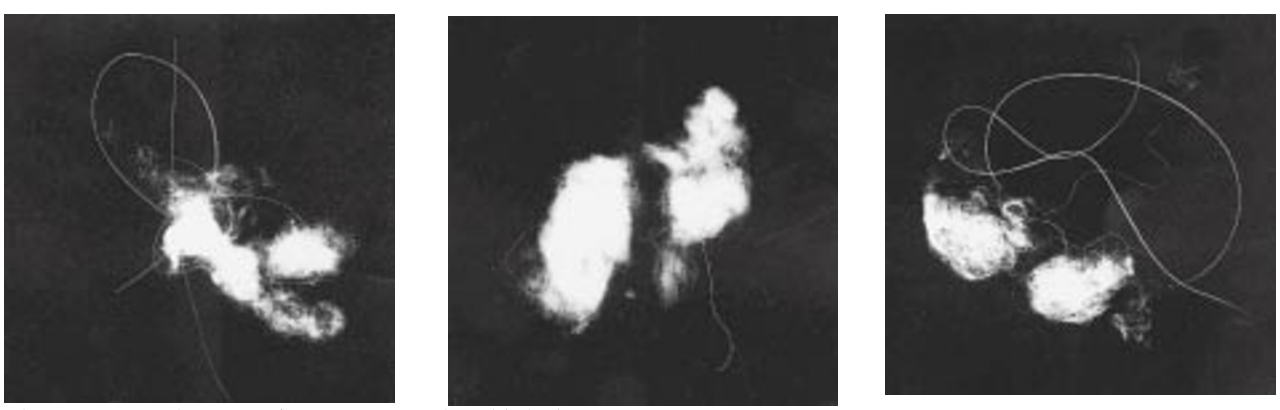
The Sima de los Huesos is part of a larger cave system in the Sierra de Atapuerca. Human remains predominate in the lower deposits of the pit itself, whereas bear bones have been excavated from overlying levels. Although there is some mixing of the bears with humans, animals other than carnivores are not well represented in the assemblage, and there are no artefacts. This suggests that the cave was not used as a living site. Some of the bears may have been trapped inside the cave later, and they probably disturbed or chewed on many of the bones[2]. But how the hominid fossils came to be accumulated there is something of a mystery. Arsuaga *et al.*[1] favour an explanation involving the people themselves — they may have dumped whole bodies in the chamber as part of an early mortuary practice.

In any case, the bones are ancient[3]. Both human and bear fragments have been dated using electron-spin resonance and analysis of uranium isotopes. The results indicate a

Avoided object

Another matter

Navel fluff: Sailor (while at sea), farmer, architect



This is a corrected version of a piece previously published.

J. TRUEBA

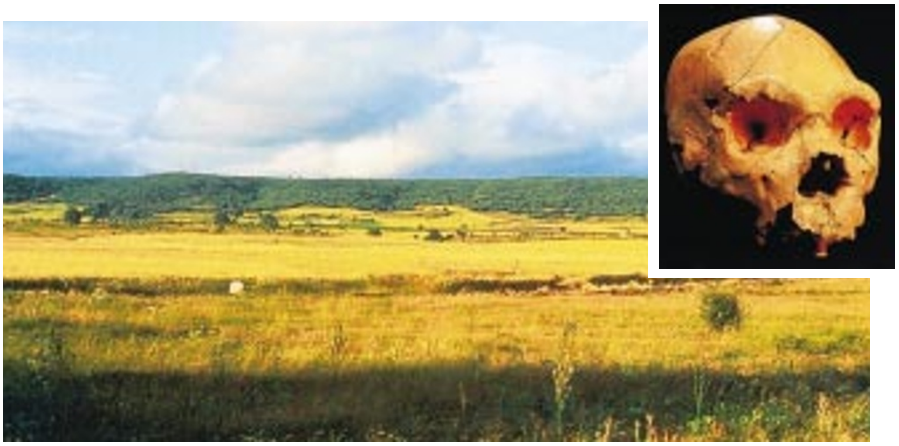


Figure 1 **The Sima de los Huesos site in northern Spain, where human body parts dating back at least 200,000 years have been found. Among them is Cranium 5 (inset), one of the most complete fossil skulls of an archaic human ever found.**

minimum age of about 200,000 years, although some of the remains could be in excess of 300,000 years old. As might be expected for specimens of such antiquity, the Sima crania show many primitive features that are found in other early Europeans, and in Middle Pleistocene skulls from Africa and Asia[4]. There are also specialized traits that suggest a link to the Neanderthals. The face is large and projecting in its middle parts and, in one well-preserved individual, the bone below the eye socket is slightly hollowed rather than flattened and continuous with the side wall of the nose. Thus, the cheek is not 'inflated' in the extreme manner of Neanderthals, although it may foreshadow this morphology. Also, brow ridges are very thick in the Atapuerca population, and the continuous form of these structures is reminiscent of Neanderthals. Additional resemblances are found in the anatomy of the temporal bone (which contributes to the side wall, ear region and base of the cranium), and in the occurrence of a shallow depression on the surface of the occiput (which makes up the rear of the braincase).

These clues are interpreted as evidence for evolutionary continuity in Europe. The Sima people seem to be related to Neanderthals. But in some respects they are intermediate between Neanderthals and still older fossils from Arago Cave in France, Bilzingsleben and Mauer in Germany, and other localities in Italy and Hungary. Although the Spanish researchers feel that there is little basis for splitting this long lineage into discrete segments, they elect to lump the Sima material — along with the more ancient remains — in the species *Homo heidelbergensis*. This taxon is said to be confined to Europe, where it is ancestral (only) to the Neanderthals. According to this 'accretion' hypothesis, Neanderthal distinctions accumulated gradually in populations that became isolated as a consequence of glacial conditions[5]. During the Middle Pleistocene (780,000–130,000 years ago), ice sheets to the north and east, and the Mediterranean to the south, would have restricted gene exchange with people outside Europe. This would have led to full expression of the morphology that characterizes Late Pleistocene *H. neanderthalensis*.

Much of this hypothesis seems sound. Certainly, the link between the Atapuerca fossils and later populations is well established. Here the Sima de los Huesos opens a unique window on human evolution in the Middle Pleistocene, and there is now good reason to suggest deep roots for the Neanderthals. However, the extent to which older specimens from Arago, Bilzingsleben or Mauer show the special features of this lineage has still to be clarified, and some workers find it difficult to separate the earliest Europeans from contemporary people in Africa or even the Far East[6]. This raises the question of how *H. heidelbergensis* should be defined. It can be argued that the species was wide ranging and not restricted to Europe. Some populations were ancestral to Neanderthals but, perhaps in Africa, there was evolution in the direction of *H. sapiens*. In this version of events, *H. heidelbergensis* is the stem from which both Neanderthals and modern humans are derived. Choosing between these phylogenetic alternatives is difficult at present, and new evidence from both the Sima and other Atapuerca sites[7,8] will have to be considered carefully as the issue is resolved. □

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Daedalus

Galactic whirlpools

Many astronomers resent the interstellar medium. It blots out their view of many interesting objects, such as the alleged black hole at the centre of our Galaxy. Daedalus sees it more positively.

He points out that all known galaxies are rotating. They spin, not like a wheel but like a bath-tub vortex. The matter near the centre travels faster than that further away — as Kepler would dictate. Yet their collective motion is still too wheel-like for comfort. To fit it to gravitational theory, astronomers must assume that each galaxy contains not only visible stars, but a vast outer ballast of invisible material. This is the mysterious 'dark matter'.

But Daedalus recalls that the viscosity of a gas is independent of its pressure. The tenuous interstellar medium should thus be about as viscous as normal air. On this basis, the vortex-like appearance of spiral galaxies is no surprise. A galaxy is indeed a vast bath-tub vortex, and its outer regions are rotated, not by the gravity of dark matter, but by viscous drag from the fast-spinning centre. He even muses that the vortex itself may be maintained by the inflow of stars and gas as they go down the awful 'plug-hole' of the central galactic black hole.

What happens to the energy viscously absorbed by the stirred interstellar medium? Daedalus calculates its Reynolds' number as well inside the turbulent region. Its energy will descend a whole hierarchy of swirls and eddies on its way to heat. This explains the puzzling heterogeneity of the medium, and the amazing temperatures it can attain — some parts reach 10^6 K, far hotter than any stellar surface. Furthermore, as in a bath-tub vortex, the turbulence must release a rude noise in some extreme low-frequency band. This will propagate as infrasound through the interstellar medium.

Infrasound originating nearby should be easiest to observe. Tenuous as it is, the interstellar medium must have a slight optical density. As its waves pass between us and the stellar background, the stars should dim and brighten slightly with its changing density. Their frequency will be very low — a cycle a year or even longer. Daedalus feels they could be best detected by continuous photon counting, for years on end, of specific star clusters (to discount individual stellar fluctuations). Data will trickle in very slowly; but who can say what advances might come from the new discipline of acoustic astronomy?

David Jones