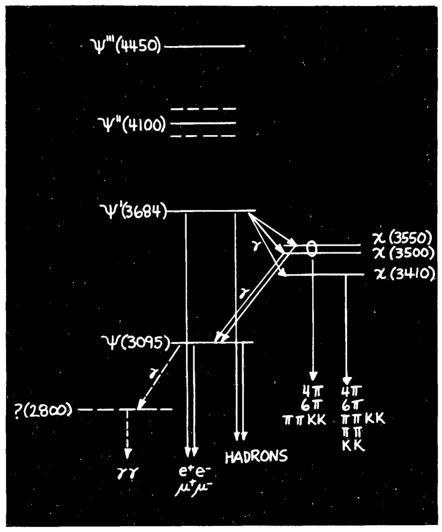
(a good indicator of general physical growth). The sample of 80 consisted of ten early and late maturing girls and boys at both age levels.

Three tests of verbal ability and three of spatial ability were administered to the subjects. The specific tests used were ones for which sex differences in the expected direction had been reliably reported. This time, when the subjects were rated along a continuum of maturation, gender did not make a difference. Waber's predictions were confirmed. Early maturers, regardless of sex, scored better on verbal than spatial tasks. Late maturers scored better on spatial than verbal tasks. The earliest maturing group (early maturing girls) and the latest maturing group (late maturing boys) showed the greatest differences. This might suggest that verbal scores increased while spatial scores decreased for early maturers (and vice versa for late maturers), but Waber found that performance on spatial tasks accounted for most of the difference between scores. Verbal ability was not significantly related to rate of maturation and will have to be accounted for by other factors.

One possible explanation for the differences between male amd female abilities is hemispherical organization. The left hemisphere is said to be lateralized or specialized for speech and language functions. But speech is not completely confined to the left hemisphere, and there are degrees of lateralization. The theory is that the more language is confined to the left hemisphere, the less it will interfere with the spatial abilities of the right hemisphere. And recent studies do indicate that speech is more lateralized among adult males than adult females. But this finding, too, might be a result of rate of maturation rather than of sex, according to Waber's findings. The early and late maturers in her sample were tested for lateralization, and the late maturers were found to be more lateralized for speech. Again, sex did not seem to be the deciding factor.

Waber says that this concept (rate of maturation rather than sex) might also apply to other seemingly sex-related behaviors not examined in her study. She concludes that "the rate of maturation (or its implicit physiological correlates) may play an important role in the organization of higher cortical functions." □

Where has my little charm gone?



Psionic spectrum: Masses, decay modes.

"Blatant is better than latent" is a slogan that appears on certain lapel buttons. It was not originally intended to apply to particle physics, but it might fairly represent the attitude of physicists toward the property of elementary particles that they call charm. For numerous theoretical reasons they want charm to exist. Recently experiments have discovered a series of unexpected, oddly behaving particles, and many theorists have concluded that these new particles contain hidden or latent charm. But to prove the existence of charm satisfactorily physicists must discover particles with overt or observable charm. That, so far, they cannot do, and their dismay was evident at last week's meeting of the American Physical Society in Washington.

To make plain the importance of charm, a little historical excursion is in order. As physicists began to discover upwards of 100 "elementary" particles, they began to feel that that was too many to be really elementary. Underlying this multitude must be a simpler, more fundamental order of being, a few simple components out of which the whole menagerie could be constructed. To these fundamentals was given the name quark.

To explain the common, well-behaved particles such as neutrons or protons requires two quarks (and their corresponding antiquarks) designated "up quark" and "down quark" or "neutron quark" and "proton quark" depending on whether one uses Californian or eastern American terminology. But at the point that the quark theory began there was already known a class of less straightforwardly behaved particles called strange particles (because of their odd behavior). To account for some of the things the strange particles did, a characteristic called strangeness was put into the theory. To have particles that possessed strangeness and behaved according to the rules that were empirically deduced for it, required a third quark in the theory, called alternately "strange," "lambda" (after a particular one of the strange particles), or "sideways."

That's about where the quark theory began. But theoretical physicists never stop for long. As it happened they were working on a unified field theory, an attempt to unite the four classes of force or interaction known to physics (which are called strong, electromagnetic, weak and gravitational) into a single description. The most successful chapter of this work involved the unification of weak and electromagnetic interactions. To accomplish it required a serious change in the theory of the weak interaction. Each interaction governs a certain group of radioactive decays and particle collisions involving those particles that respond to its forces. Until a year or two ago a characteristic of the weak interaction was that its processes always involved the exchange of a unit of electric charge between the participants. (In the jargon, such processes are called charged currents.) But to unite the weak interaction with electromagnetism the theorists had to introduce weak-interaction processes that did not involve electric-charge exchange (called neutral currents).

Now it happens that the charged-current weak processes always involve a simultaneous change in strangeness if a strange particle happens to take part in them, but the neutral currents do not change strangeness. To prevent the change of strangeness in the latter case, theorists had to postulate a new characteristic that would hold the strangeness fixed. This, they called arbitrarily "charm." Since none of the three quarks in the theory had any charm, a fourth, charmed quark had to be put into the theory to be a constituent of particles that had charm. So now we have four quarks, u, d, s, and c.

Just as there are particles that exhibit electric charge and behave according to rules appropriate for it, and just as there are particles that exhibit strangeness and behave according to the rules appropriate for that, so there ought to be particles that exhibit charm and behave according to its rules. About two years ago experimenters began to set up arrangements to look for them. Meanwhile, came the quite unexpected discovery of a gang of particles now collectively called "psionic matter," which may or may not be the repository of latent or hidden charm.

The first of these new particles, called psi in the west and J in the east was found simultaneously at the Stanford Linear Accelerator Center in California and at Brookhaven National Laboratory in New York. It was heavier than any other known particle. For something so heavy it had a long lifetime compared to the lifetimes of other heavy particles.

In something less than a year and a half, since November 1974, at least eight other particles related to the first psi have been found, mostly in the products that appear after the annihilation of colliding electrons and positrons. Collectively they have been dubbed "psionic matter." A spectroscopic chart can be drawn to show how they decay, sometimes into one another, sometimes into previously known particles.

Theorists, considering psionic matter, decided by a large majority that the predicted property, charm, was at work there, but hidden charm, not explicit charm. As Vera Luth of the Stanford Linear Accelerator Center draws the picture, the consensus seems to be that the basic structure of psionic matter consists of a charmed quark and an anticharmed antiquark (thus exhibiting no charm overall). This configuration can exist at a number of different energy (or rest mass) levels. Each of the quarks possesses spin, and the system as a whole has angular momentum because the two quarks are seen as revolving around each other much like a binary star system or an "atom" of positronium. Changing the direction of either or both quark spins, adding energy to the system's angular momentum or any combination of those processes will yield a new rest mass and define a new member of the psionic family.

Two main points make theorists suspect that charm is at work in this picture. One is the comparatively long lifetimes. The heavier particles in physics usually decay by means of the strong interaction. Strong decays go fast, and hence, the particles have short lifetimes. But according to the hypothetical rules for charm laid out by the theorists, the total amount of charm should be conserved in strong decays. That means the most plausible strong decay for the psi particles would be into a pair, one of which displayed charm and the other anticharm. The problem is that the lowest-mass psi came in at about 3,100 million electron-volts (3,100 MeV). For it to decay by the strong interaction there would have to be particles exhibiting charm and anticharm at about half its mass. Particle searches around 1,500 MeV have been many and thorough, but nothing of the kind is known. Therefore the low-mass psi's, if they decay at all, must resort to the weak interaction, which by hypothesis does not conserve charm, and weak decays mean long lifetimes.

The second point is that if the psi particles form a succession of states of the same basic structure with higher and higher masses, the higher ones ought occasionally to pass to lower ones simply by giving up the excess energy in the form of photons or quanta of electromagnetic radiation. Such occurrences have been observed in more than one laboratory.

All this leads both theorists and experimentalists to believe, as Min Chen of the Massachusetts Institute of Technology puts it, that some new quantum number is hidden in the behavior of psionic matter. But Luth cautions that there is no direct evidence that that quantum number is charm or at least charm as the theorists have postulated it. If experimentalists use the word, she says, it is because it is ready to hand and somewhat plausible.

What would clinch the case is the discovery of a particle or particles that show explicit charm and are related to the psi's. If there are none at energies much under 4,000 MeV—and nobody has found any—maybe they exist at higher energies. Kenneth Stanfield of Purdue University, who represents an experiment at the Fermi National Accelerator Laboratory that began looking for charmed particles before the discovery of psionic matter, says that even though the Fermilab equipment can search higher energies than other setups, no such animal has yet been seen. Luth and Chen, representing the experiments that originally found the J/psi, concur. No one anywhere else has put forth a solidly regarded claim.

So what to do? The first thing is to go on searching at higher and higher energies. Another possibility is to look for rare phenomena. Chen points out that perhaps an overtly charmed particle signifies its presence by an unusual mode of decay, a three- or four-body decay that nobody has yet thought to examine the data for.

One can also rethink the theory in part or in whole. Perhaps the theory is wrong about charm, says Chen. Or maybe, he speculates, charm is like magnetic poles: Charm and anticharm must always appear bound together like north and south poles, and there is no way to break them apart. Cut a magnet in half and you get two new magnets, not separated north and south poles. That may be what psionic matter is trying to teach us about charm. □

Academy calls for freedom of inquiry

Apparently responding to reports of scientists being persecuted in the Soviet Union and other countries, the National Academy of Sciences last week issued a statement calling for worldwide freedom of inquiry and expression, and invited others to join in the declaration. Copies of the statement are being widely distributed, and the Academy will keep a file of those responding. It is not yet clear what actions will be taken to see that the supposed perpetrators of repression get the message.

Affirmation of the statement came at the Academy's annual meeting, following a strongly worded address by NAS president Philip Handler. "The Academy must learn its own mind in these matters," Handler said, and "must decide whether it has a responsibility or obligation to speak to violators of the human rights of scientists or other intellectuals wherever these may occur." He said it must also decide whether to use exchange programs with Communist countries as leverage in pursuit of these principles.

The Academy has received numerous requests to remonstrate Soviet officials, Handler said. Complaints have alleged that scientists have been exiled and jailed, have lost position and professional status and have been refused permission to emigrate. He said that from South America, too, have come reports of physical abuse of scientists and intellectuals.

The statement signed by Academy members does not attack these abuses directly, but rather calls for basic freedom to conduct and report research without fear of retribution. The search for knowledge, it says, should be conducted "without religious, political or ideological restriction." Discoveries and ideas should be freely disseminated, and those engaged in these pursuits should be free to travel and publish. The resolution also reaffirms the concept of personal, as well as professional, freedom, "upholding a universal belief in the worth and dignity of each human being."

One interesting consequence will be to see the reaction of those in this country who claim to have lost professional standing for holding unpopular views. The resolution specifically states, "Those who challenge existing theory must be protected from retaliatory reactions."

The final importance of the document, of course, will rest in what action is taken on it during negotiations, either by the Academy or the State Department, and what sanctions are imposed. Past decrees have had little effect in this arena. □

One for the optimists

A new report from Herman Kahn's Hudson Institute provides an optimistic counterpoint to the gloom-sayers. The world, it concludes, is now entering the period of fastest economic growth in its history, during which population will be brought under control and the gap between underdeveloped and industrialized countries will be closed.

These conclusions are contained in *The Next 200 Years—A Scenario for America and the World,* which directly contradicts the conclusions of *The Limits of Growth,* an earlier study produced by the Club of Rome. Rather than having economic growth stop, for fear of pollution or starvation, Kahn would have the development process speed up. "The gap between the rich nations and the poor nations is the strongest force in making the poor nations richer," he says. Already the economies of the underdeveloped nations are growing twice as fast as did America's pioneer society, and technology transfer will facilitate the development process.

By 200 years from now, the report predicts, the population of earth will have leveled off at about 15 billion people, and per capita income will have risen from $1,300 to $20,000 (constant 1972 dollars). Coal will be adequate to fulfill energy needs until such "perpetual" sources as fusion and ocean thermal energy are available, and new agricultural techniques can overcome the threat of famine. □