will get their delay. Because of the short Arctic construction season, even the 90-day review period they requested will delay the beginning of construction for another year. Conservationists believe that with enough time, the facts of the environmental hazards of the pipeline will penetrate deeply enough into officialdom to defeat the project. It is beginning to look as though there is a chance they could turn out to be right. □

MASS TRANSIT

Air cushion to Dulles

One of the most glaring failures in the nation's transportation system often faces the traveler after a 500-mile-an-hour flight on a jet plane: A snail's pace ride into the destination city via taxi or bus on crowded highways or freeways. Travelers talk of the 29-mile ride into the city from Washington's beautiful and efficient Dulles Airport, nestled in the Virginia countryside, as often taking nearly as long as the flight from, say, Minneapolis.

Transportation Secretary John A. Volpe says a partial remedy is in store for Dulles travelers, one he hopes will serve as a model for other cities where downtown and airport are widely separated. To be constructed from Dulles to McLean, Va., are 13.5 miles of track for tracked air-cushion vehicles (TACV), which will run on linear induction motors and be engineered for speeds up to 150 miles an hour (SN: 12/19/70, p. 464). Volpe hopes the vehicles can be running by the time of an International Transportation Exposition to be held at Dulles in the late spring of 1972.

The project is mainly for technological demonstration purposes, and, in terms of actual service to travelers, it will fall short in several ways. From McLean to downtown Washington is an additional seven miles, even as the crow flies, and travelers may find a single vehicle trip via bus or car more convenient than changing at McLean, to board the air-cushion vehicle. But Transportation Department officials say the new Washington Metro system will provide subway connections to McLean by 1976. It is conceivable, they add, that the TACV system could eventually be extended into Washington.

The main reason for selecting Dulles, they say, is because the existing McLean-Dulles highway is owned by the Department, and the TACV system can be built on the highway median strip with minimal right-of-way problems.

The TACV proposal came in a Volpe speech on Washington's perplexing transportation problems. Other proposals included restrictions on automobiles in parts of the city. □

PARTICLE THEORY

Twelve subnucleons

When physicists first discovered that atomic nuclei could be subdivided, they speculated that nuclei consisted of protons and electrons held together by the electric force between those oppositely charged particles. The discovery of the neutron put an end to this model. It was seen that whatever bound the nucleus together operated equally on the charged proton and the uncharged neutron and that its intrinsic strength was much greater than the intrinsic strength of any known electromagnetic force.

The nuclear binding was therefore considered a force of a different kind and entered physics under the name strong interaction.

Later the so-called weak interaction entered the picture. This force characteristically presides over radioactive processes that change a particle of one identity into a particle of another identity. Nuclear beta decay, in which a neutron inside a nucleus changes itself into a proton is the classic example. Processes governed by the weak interaction are characteristically slower and weaker than those of the strong interaction, and therefore the weak force has to be considered separately.

This plethora of forces—there is also some evidence that the weak force can be subdivided; in different processes it appears with different intrinsic strengths—is a bother to physicists, who have a strong desire to find simplicity and unity in nature. To satisfy this desire a professor of physics at the University of Auckland in New Zealand, Dr. P. C. M. Yock, presents for his colleagues' consideration a theory that refers all the forces ultimately back to the electromagnetic interaction.

Dr. Yock calls his theory "a unified theory of strong and electromagnetic forces." He has been developing it over the last few years, and in the December 1970 ANNALS OF PHYSICS he presents a summary that expresses the physical implications of his mathematics.

Like many other current theories of particle physics, Dr. Yock's begins with the assumption that the particles usually called elementary are not elementary at all. Dr. Yock postulates that all known particles are composed of six subnucleons, as he calls them, and six antisubnucleons. The most current rival theory postulates only half as many basic entities: three quarks and three antiquarks. Dr. Yock's subnucleons are electrically charged bodies as are the quarks, but subnucleons have charges that are large multiples of the basic particle charge, that of the electron. Quark charges are fractions of the electron charge. The subnucleons have charges approximately 10, 20, 30, 40, 41 and 11 times the electron charge. Proper combinations of the plusses and minuses can give the smaller charges of the observed particles.

Dr. Yock can explain all the observed particles as combinations of several of the 12 basic entities. His theory, he says, is consistent with all the known laws of physics and yields the proper rules for the conservation of mass, electric charge and other more exotic qualities of particles that appear experimentally to be conserved.

He believes that the subnucleons are bound together to form the observed particles by a very strong electromagnetic force caused by their very large charges. He regards the strong interaction as a weaker version of the same thing, and the ordinary electromagnetic forces as a weaker version still. He makes an analogy to the difference between atomic bonds, those that hold electrons and nuclei together, and molecular bonds, which hold atoms together in molecules. Atomic and molecular bonds are both electromagnetic in nature, but atomic bonds are much stronger.

As for the weak interaction, Dr. Yock distinguishes four different forms, each with a different intrinsic strength. Three of these he fits into his theory; the fourth remains for the moment out of it.

The major defect of Dr. Yock's presentation is that it makes many qualitative, but no quantitative predictions. He excuses himself by saying that it is extremely difficult to calculate quantitative predictions in any theory of particle phenomena, and he hopes that publication of his ideas will persuade others to join him in the job.

He does estimate that the mass of a free subnucleon is something like 100 times that of a proton. When they bind together much of this is lost. The characteristic dimension over which subnuclear interactions should make themselves felt is about 10^{-16} centimeter. Nuclear forces have a range about 1,000 times that.

So far there is no direct evidence for the existence of subnucleons, but two recent observations give Dr. Yock ammunition for indirect arguments. In 1967 Dr. Peter Fowler of the University of Bristol in England and coworkers found massive, highly charged objects among the cosmic rays that they could not explain as heavy atomic nuclei or any other known particles.

In 1969, Dr. C. B. A. McCusker of the University of Sydney in Australia found unusual tracks in cloud-chamber pictures. Dr. McCusker thinks his unusual tracks were made by quarks, but Dr. Yock thinks both instances can be used in favor of his subnucleons. □