Such conditions would be present in neutron star envelopes, which would have a chemical composition of nuclei with atomic weights between 200 and 500, plus free neutrons. Instabilities in the neutron star could eject such matter from the surface. Chechotkin and Kowalski calculate what would happen to it after ejection. By 0.4 seconds after ejection more than half of the original nuclei, which start out at atomic number 161 and atomic weight 644, evolve by capturing free neutrons until they reach atomic number 184 and weight 736. By half a second after ejection nearly all the nuclei in the ejected matter have so evolved.

These ultraheavy nuclei then undergo spontaneous-fission and beta-decay chains to produce both superheavies and the heavy elements already known to chemistry. Chechotkin and Kowalski consider the known density of heavy elements in the universe and the best present estimate of the number of neutron stars (a billion) and conclude that the outlined process could produce the heavy elements under the assumption that 10 percent of the envelopes of the neutron stars form heavy elements and are ejected.

Thus, the space in the neighborhood of neutron stars may be enriched with heavy and superheavy elements, and some of these could find their way to the surfaces of other nearby stars. Such a process could explain the presence of heavy elements on the surfaces of stars (such as promethium 145 in some Ap stars) that processes within the stars do not seem to be able to account for. □

Probing space for gravity waves

Gravitational waves are, according to Einstein's theory, gravity's analog to electromagnetic waves such as light, radio and X-rays. Electromagnetic waves are generated by accelerated motion of charged bodies. Gravitational waves ought to be generated by accelerated motion of massive bodies. The passage of electromagnetic waves can be detected by jiggles that they cause in the motion of charged bodies. Likewise, the passage of gravitational waves should be detectable by jiggles in the motion of massive bodies they encounter.

For technical and scientific reasons, gravitational waves are far more difficult to detect than electromagnetic ones. Nevertheless, about seven years ago Joseph Weber of the University of Maryland reported that he had detected them, but no one else has seemed to be able to confirm his finding. Now an American and a Russian physicist, Kip Thorne of the California Institute of Technology and Vladimir Braginsky of Moscow State University, propose a spacecraft experiment to try to confirm the existence of the waves.

Weber was looking for fairly high frequency, short waves (in the range above 1,000 hertz). He used metal bars for detectors. The passage of the waves should produce extremely minute fluctuations in the surfaces of the bars. Thorne and Braginsky propose an antenna that would use the earth and a space probe flying beyond Mars to detect extremely long waves, 10 million kilometers or more in length with periods of 30 seconds or greater. The Thorne and Braginsky proposal is floated in the Feb. 15 ASTROPHYSICAL JOURNAL.

As waves of this length passed through the solar system, they would cause fluctuations in the motions of the spacecraft and of the earth. The difference could be measured by the Doppler shift in the radio signals that track the spacecraft.

The basic idea is not new, but the proposal is made practical now by what Thorne calls "a revolution in clockmaking" led by John Turneaure of Stanford University. Instead of using atomic vibrations as frequency standards, the new clocks will use classical electromagnetic waves standing in a superconducting waveguide. They promise to increase precision by a factor of 50 to 500 over current hydrogen-maser clocks. This should be sufficient to control the frequency of the spacecraft tracking signal sharply enough to distinguish the gravity-wave-induced Doppler shift.

The proposal is being made separately to the Soviet and U.S. space agencies. A joint experiment is not feasible because the Soviets keep their deep-space tracking data closely secret and would be highly unwilling to share them. □

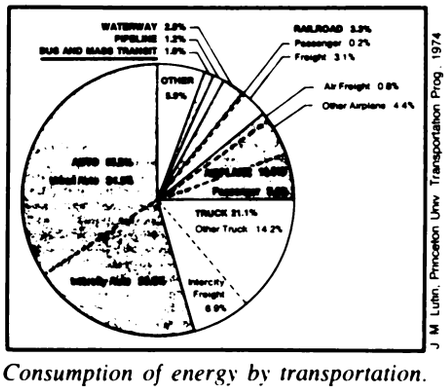
Mass transit: Limited impact

Just increasing mass transit facilities and their use can have only very limited impact on efforts to improve energy conservation and the economy, according to a new study by the congressional Office of Technology Assessment (OTA). Such measures would have to be combined with stringent, direct restrictions on private automobile use in order to be effective, the report concludes.

The findings, summarized in the OTA report *Energy, the Economy and Mass Transit*, are simply the latest confirmation of that well-known phenomenon, the "love affair" between Americans and their cars. Even totally eliminating fares on urban mass transit systems would apparently not dissuade auto commuters, and though it would increase transit ridership by 60 to 80 percent, the effect on fuel conservation would be almost negligible. The effect on unemployment would also be modest: Each million dollars of capital investment for mass transit results in about 80 man-years of employment (some 3 percent more than highway construction), and building new subway systems and the like tend to affect employment only locally.

Such conclusions strike at the heart of ambitious schemes for solving the nation's energy and economic ills through vast public works projects aimed at rapidly improving urban mass transit systems. On the other hand, combining improved transit service with direct penalties on auto use could result in substantial savings. The automobile accounts for 98 percent of fuel used in urban passenger transportation and 13.6 percent of the nation's total energy use. The passenger miles produced by a unit of energy during rush hour is 15 times greater for a bus than a car, and more than 27 times greater for a subway train. And despite the trend to smaller cars, automobile fuel efficiency continues to decline.

Penalties on private auto use would have to be pretty severe, however, to show any effect: During the recent oil embargo, most people apparently cut back on discretionary auto travel rather than switching from cars to mass transit. Estimates from OTA indicate that such direct restraints as $1.50 per day increase in the price of commuter parking would have a greater effect on transit ridership than a 50 percent increase in the price of gasoline, which in turn would have 10 times more effect on reducing gas consumption than the maximum "pure-transit" strategy, including free fares. (Such free mass transit would cost about $5 billion a year and could be financed by a gasoline tax of as little as 15 cents per gallon, applied only in metropolitan areas.)



Consumption of energy by transportation.

Meanwhile, existing funds for improving transit facilities have encountered interesting local resistance: The vast majority of federal funds made available in 1974 for public transportation are being used by communities for operating expenses rather than facility improvement. This is true despite a substantially greater requirement for matching local funds. The OTA notes that if the Urban Mass Transportation Administration (UMTA) had more flexibility in setting requirements for matching funds, it could encourage communities to initiate new transit programs. □