polarized, directional and complex pulses are generated is reserved for a later instalment.

Like everyone else these days, the authors start with the assumption that pulsars are spinning neutron stars with a magnetic axis which is not the same as the rotation axis. Such a star loses energy by magnetic dipole radiation so that the spin, and thus the rate of pulsation, slows down. On this basis the age of *NP* 0532 comes out as 25 per cent greater than the age of the Crab Nebula itself, and Ostriker and Gunn attribute the discrepancy to gravitational quadrupole radiation. Indeed, they say, gravitational radiation must have been the dominant form of energy loss for the first eighty years after the birth of the Crab Nebula in AD 1054.

Something like 10^{51} ergs of magnetic dipole radiation are lost during the lifetime of a pulsar such as *NP* 0532. What happens to this energy, which is in the form of intense electromagnetic radiation with a frequency matching the rotation rate of the pulsar, 30 Hz for *NP* 0532 ? Ostriker and Gunn claim that the radiation is an efficient accelerator of particles to relativistic velocities. Naturally enough, these particles are suggested as the enigmatic energy source which keeps the Crab Nebula glowing, and Ostriker and Gunn also count themselves among those who consider that pulsars make a significant contribution to the flux of high energy cosmic rays.

The paper ends with a prediction of the second derivative of the period of *NP* 0532: $d^2P/dt^2 = -0{\cdot}016$ ns day^{-1} yr^{-1} if gravitational radiation is not at present important, and $-0{\cdot}021$ ns day^{-1} yr^{-1} if it is. These figures must be compared with an article in the letters section of the same issue of the *Astrophysical Journal* by P. E. Boynton *et al.*, also of Princeton, who report six weeks of precise observations of *NP* 0532 using a 36-inch optical telescope at Princeton (**157**, L197; 1969). Their value for d^2P/dt^2 is $-0{\cdot}0404 \pm 0{\cdot}0095$ ns day^{-1} yr^{-1}. The result seems to be more consistent with loss of energy by gravitational radiation than by magnetic dipole radiation alone.

CATASTROPHES

Hawaii Hit Hard

from our Geomagnetism Correspondent

In 1960 an eighteen-foot tidal wave originating in Chile struck Hilo, the principal city of the island of Hawaii, killing sixty-one people, injuring 282, destroying 537 buildings and causing damage estimated at $23 million. Its force was sufficient to carry a twenty-two ton boulder 546 feet from the sea wall. Today, affluence in Hilo is measured in feet above sea level—from expensive villas high on the hill overlooking the bay to shabby homes and shops which still cluster around the sea front in the downtown area. Only vacant lots mark the scene of past tragedies.

The Hawaiian Islands are prone to tsunamis, with Hilo receiving the greatest impact because of the configuration of its harbour. According to a new history of seismic sea waves in Hawaii (*A Catalog of Tsunamis in the Hawaiian Islands*, by George Pararas-Carayannis, US Environmental Science Services Administration), the Hawaiian Islands have been struck by eighty-five tsunamis since 1813, causing at least 385 deaths, the destruction of more than 1,500 homes and total damage estimated at at least $57 million. The most destructive tsunami, in 1946, killed 173 people in Hilo and destroyed 488 homes in a $26 million holocaust. The earliest recorded tsunami occurred in 1819 when a three-foot wave originating in Chile hit the west coast of Hawaii, though the first destructive wave was that of 1837 which killed sixty-two and destroyed 310 homes on Maui and Hawaii. Presumably tsunamis reached the islands before 1813, but the ancient Hawaiians kept no records.

More than half of the recorded tsunamis originated in the North and North-west Pacific among the Aleutian Islands and the Kamchatka Peninsula of Siberia. About a quarter began along the South American coast. Waves generated in the Philippine, Sulu, Celebes, Molucca, Java and South China Seas, though destructive in the immediate area of origin, generally have most of their energy tapped by the many islands on the way to Hawaii. Only four of the tsunamis recorded during the past century were of local origin, although that of 1868 was one of the four most destructive, killing between 81 and 148 (the number is in dispute) and destroying 108 homes. At that time the South Puna coast (Hawaii) subsided three feet under the highest wave ever recorded in the islands.

In spite of the high frequency of tsunamis (about one every two years with a loss of life at least every twenty-six years on average), people still continue to live in the areas of greatest danger, although it is now somewhat mitigated by the international tsunami warning system in the Pacific operated by the US Environmental Science Services Administration. Presumably they are willing to take the risk for the same reason—whatever it is—that millions of Californians are happy to sit on the San Andreas Fault.

PRODUCTION CONTROL

Computers on the March

The conference on production control by computer, held at the Queen Elizabeth Hall, London, on October 16, turned out to be lively and generally informative. Most speakers managed to convey their own experiences with computerized production control to the 1,100 delegates without too much jargon. In particular, Mr H. S. Woodgate of ICL, who discussed the philosophy behind the introduction of computers into production control, gave a forceful insight into how production and sales departments can become disjointed and incoherent as the size of a company increases from the "ideal" situation, with one general manager and a staff of about twenty.

The impetus for the conference came from the development by ICL of three types of software package systems for use in production control. The basic type, known as PROMPT, links together the functions of requirement planning, stock control, purchase control, plant loading, works documentation and progress control, and, as Mr Woodgate pointed out, is designed to fit the requirements of an "average" company. A spirited account of the application of the PROMPT system came from a French contributor, Mr J. Hincelin of GIE-Interfirm, who described how two smallish companies, Gambin and Carpano, with turnovers of £4 million and £8 million respectively, had joined forces to form what is known as a GIE (Groupements