

Physics monitor

The NUSEX experiment by a CERN/Frascati/Milan/Turin group in a gallery off the Mont-Blanc road tunnel – an unexplained source of particles coming from a binary star.

Cygnus signal

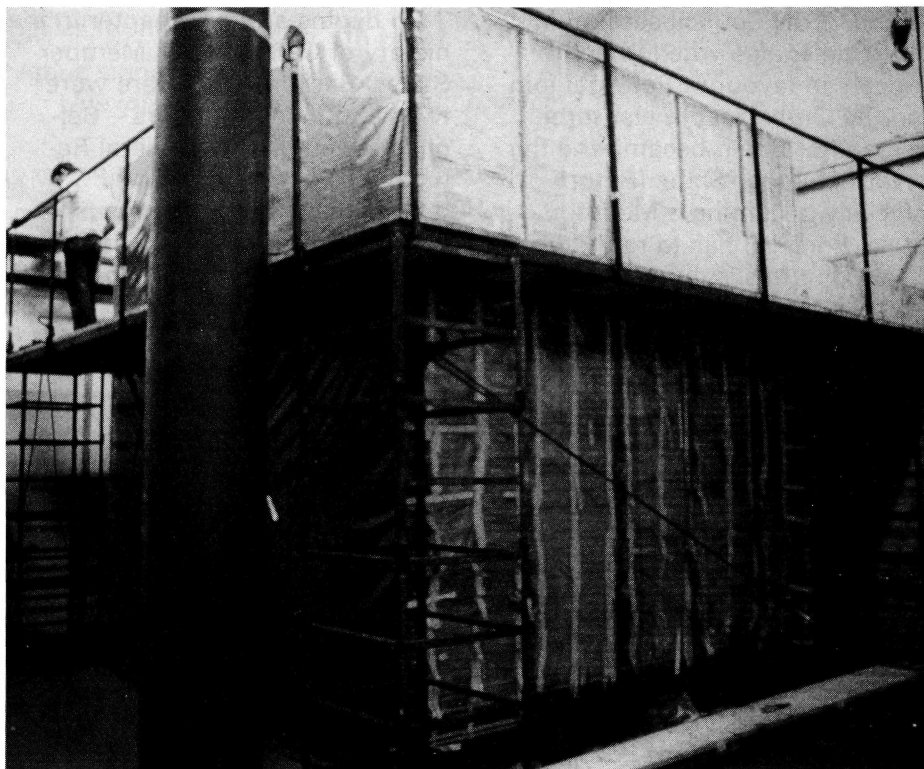
The advent of big underground detectors looks to be bringing in its wake a new branch of physics – elementary particle astronomy. One of its first results is confirmation of an intense source of particles coming from the binary star Cygnus X-3.

Some ten years ago, the first formulations of 'Grand Unified Theories' ambitiously tried to pull together the new electroweak unification with the strong force binding quarks into nucleons (and in turn into nuclei). The big spin-off prediction from these ideas was the instability of the proton, especially in the (in principle) easily observable decay into a positron and a neutral pion.

To check this out, a range of big underground experiments quickly got off the mark, with hundreds of metres of rock screening off cosmic rays. With samples weighing hundreds, even thousands, of tons, these experiments had plenty of protons to watch.

The first big new experiment to become fully operational was by an Irvine/Michigan/Brookhaven group in the Morton Salt Mine, Ohio. Using several thousand tons of water, this experiment should fairly quickly have picked up signs of proton decay if it happened at the predicted rate. It didn't.

The negative result was underlined by other underground experiments (NUSEX by the CERN/Frascati/Milan/Turin group in the Mont-Blanc road tunnel, the Japanese Kamioka study, and other projects – see April 1983 issue, page 79). Protons just don't decay fast enough for the simplest Grand Unified Theory to be right. (With the predicted proton lifetime of



10^{32} years, just one human proton in a medium sized city should decay every hour.)

If protons decay more slowly, then the detectors have to look harder. The main problem now is to disentangle any signal from the background caused by cosmic neutrinos. During this time, the underground detectors might well find other things...

Cygnus X-3 was discovered in 1961. Five times brighter than the sun, it emits radiation with a period of 4.8 hours – too long for a pulsar. It was quickly identified as a binary star, emitting ultra high energy photons as well as X-rays.

After the initial astronomical surveys, cosmic ray experiments on the earth's surface picked up air showers with a relatively high muon content coming from the direction of Cygnus X-3 and which

oscillated in time with the X-rays. Such a high muon flux was surprising as even ultra high energy photons crashing into the earth's atmosphere should be a relatively weak source of muons. The observed muon signal was more in line with what would be expected if the binary star also emitted heavier primary particles.

Ultra high energy muons are highly penetrating particles, capable of piercing the earth's surface before being absorbed, and therefore easily seen in the big underground detectors.

Both NUSEX and the smaller Soudan (Argonne/Minnesota/Oxford) experiment in a Minnesota mine have now identified high energy muons reaching their detectors from a narrow cone around the direction of Cygnus X-3, and whose signal comes and goes