Alternate source of fifth force challenged

Some physics experiments appear to indicate the presence of a fifth force in the universe; others find no evidence for this phenomenon. Last year, several physicists suggested these apparently conflicting results might prove consistent—if the source for the force differs from that originally proposed (SN: 10/3/87, p.212).

However, findings from two new reports challenge the idea the conflicting results can be reconciled. As a result, any consensus regarding the existence of a fifth force seems as distant as ever.

The term fifth force derives from the fact it would augment the four known forces — electromagnetism, gravity and the strong and weak forces that bind atomic nuclei. Its existence was proposed two years ago to account for discrepancies between the strength of gravity measured underground and at the earth's surface. Unlike gravity, which acts on all matter, this proposed force would affect only particles closer together than a few miles or less. The hypothetical force also would differ from gravity, which acts on matter in proportion to mass, by influencing atoms on the basis of baryon number — the sum of neutrons and protons.

In August 1987, Eric G. Adelberger and his co-workers at the University of Washington in Seattle suggested that a disagreement between their experimental results and those obtained by Peter Thieberger of Brookhaven National Laboratory in Upton, N.Y., could be viewed as compatible only if the source of the force were instead isotopic spin — the number of neutrons *minus* the number of protons. The Washington team's experiments, conducted with a pendulum apparatus, found no confirmation of an unknown force, while Thieberger, using a water-tank device, reported evidence for a relatively strong force. If the force depended on "isospin," then the unusual surplus of protons in water might have profoundly affected Thieberger's observed results.

Paul Boynton, leader of a second Washington research team investigating the fifth force, analyzed these two groups' experiments and one his own group performed with an apparatus and materials similar to those used by Adelberger. Boynton concluded the results of each experiment would be consistent with the existence of a force tied to isospin. He suggested an isospin source might render the results of all fifth force experiments compatible, which prompted other researchers to test the hypothesis.

In the Sept. 19 PHYSICAL REVIEW LETTERS, Clive C. Speake and Terry J. Quinn report that the results of an experiment they carried out at the International Bureau of Weights and Measures in Sèvres, France, restricts the possible strength of a fifth force dependent on isospin. In an approach unique among fifth force experiments, Speake and Quinn used a beam balance to measure potential attractions between objects. Despite producing the most sensitive weighing ever, Speake says, the experiment did not rule out the isospin idea. Reaching any definitive conclusion regarding the hypothesis with this method would require an even-more-sensitive beam balance, says Speake, now at the University of Colorado's Joint Institute for Laboratory Astrophysics in Boulder.

Adelberger, however, now disputes the isospin explanation as a valid means of reconciling contradictory experimental results. Last January at a conference in Les Arcs, France, he presented physicists with preliminary evidence he says precludes the possibility. His team tested the isospin proposal by placing a ton of lead, containing more than 1.5 times as many neutrons as protons, next to his measuring apparatus. Still, he said at the conference, no evidence for an unknown force was observed. "This doesn't mean Boynton's experiment is wrong," he told SCIENCE NEWS. "It just means this [isospin] way of trying to resolve the differences between the experimental results is probably wrong." Adelberger says a report by his group, scheduled for publication in PHYSICAL REVIEW LETTERS, makes this case even more convincingly.

"The result of Adelberger's group's experiment is certainly suggestive but not airtight," Boynton says, adding, "the isospin hypothesis can be rejected by that experiment only if the fifth force acts on bodies closer together than a kilometer or so." An isospin-dependent fifth force acting over a distance of 1 to 10 kilometers remains a possibility, he says. — *C. Knox*

DNA from single sperm spurs gene studies

In an advance important to solving many difficult problems in human genetics, a team of researchers has announced the first mass production of copies of DNA taken from a single sperm cell. The technique should prove useful, they say, in locating the genes responsible for a number of inherited diseases and in making detailed genetic maps.

Mapping where genes lie in chromosomes is now done through selective breeding experiments or by analyses of animals with many offspring. Because the first option cannot be used to study humans, scientists studying the human genome must analyze large families, which can be hard to find.

The construction of a genetic map is based on the fact that, as sperm is made, genes are "shuffled" in a process called crossing over, in which segments of DNA are switched with similar segments on the same chromosome. If two genes sit very close together along a chromosome, chances are they will remain together on the segment that crosses over. It is much rarer that the DNA breaks between them so that one gene moves and the other is left behind. For instance, if nearsightedness and a misshapen toe always show up together in members of a family, it could indicate the genes for these conditions lie close together on the chromosome.

But finding out how close requires a statistical analysis of how often the genes become separated. This demands the study of a family with many children. Families must be particularly large if scientists want to find the distance between genes that are close together, because closely paired genes are infrequently separated in a crossover. Such families are "a rare commodity," says Randall Saiki of Cetus Corp. in Emeryville, Calif., one of the researchers describing the new work in the Sept. 29 NATURE.

The new technique gives scientists the chance to analyze DNA of thousands of individual sperm, each with different genetic shufflings. This, in effect, enables them to analyze the DNA of thousands of children. The number of sperm that can be analyzed will "depend on the extent to which the process can be automated," says Norman Arnheim of the University of Southern California in Los Angeles, who led the study.

Arnheim, Honghua Li and their colleagues at USC and Cetus were able to analyze DNA from sperm cells because they worked out how to make many copies of the sperm's DNA using the relatively new technique called polymerase chain reaction. This technique has previously been used to analyze the DNA obtained from groups of cells, including hair cells, and to find AIDS virus hidden in the cells of those infected with it (SN: 4/23/88, p.262; 6/4/88, p.357).

The scientists say that applying the technique to sperm should help analyze chromosomal "hotspots" where genetic crossovers seem to occur far more frequently than they do throughout most of the genome. The analysis of individual sperm also offers a chance to learn whether some people have a greater propensity to shuffle genes than others.

The method should also provide a kind of golden spike to link up the two great lines of genetic analysis: that of genetic "distance" (actually not a true distance but rather the probability of genes being separated during crossing over) and that of isolating and directly measuring much smaller gene fragments. "Now we can get some idea of what the real relationship is between physical distance and genetic distance," Arnheim says. — *C. Vaughan*