news

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IMMEDIATE

For generations, with the approach of Christmas, parents around the world have faced the same merciless questions from curious offspring: How does Santa Claus visit everybody's house in one night? How does he know if you have been bad or good? Why does he never grow old?

This holiday season two graduate students at The University of Chicago believe they have succeeded in providing the explanation. Gary Horowitz and Basilis Xanthopoulos, both general-relativity students in the University's Department of Physics, say the key to these puzzles concerning Santa Claus lies in his speed. Santa, they say, moves almost as fast as light, and everything follows from that fact.

Taking into account the rotation of the Earth, Santa has 24 hours of night to stop at every household in the world on Christmas Eve. Calculations show that, with approximately two billion households evenly distributed over the Earth's surface, Santa must travel about one hundred million miles during that night.

But wait! It is not enough for our "right jolly old elf" to zoom around the world and pass every house. At each home, he must stop, enter, leave off presents and make his exit before accelerating to full speed to reach the next house. Santa, according to calculations, can spend about one half of one ten-thousandth of a second at each house (no wonder the kids never see him!) and still have half an hour to cover the 100,000,000-mile distance. To do this, he travels at nearly 70,000 miles per second; this speed, considerably beyond the average family car, is still only 40% of the speed of light and no challenge at all for Santa.

Santa knows who's been bad and who's been good because, throughout

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the year, he flies from house to house at speeds even closer to that of light, quantum-mechanically "tunneling" through our homes to check up on us. (This quantum-tunneling process is well known among scientists and is useful in modern electronics.) The tremendous acceleration that Santa continuously undergoes in travelling from house to house helps keep him young, because time slows down for accelerating bodies.

But how does he generate the immense quantities of energy needed to achieve these accelerations? At the North Pole, Santa has a rotating black hole, a dense object collapsed under its own weight to the point that even light cannot escape it. When he needs more energy for his journeys, Santa can swing in very close to the vortex without falling in and dump defective toys into the hole. By a technique known to relativists as the "Penrose process", he leaves with more energy than he had originally.

Some future Christmas, however, Santa will face his own "energy crisis," because the black hole's rotation is slowed every time he uses it. When it comes to a stop, so will he, unless his elves can devise an alternate energy source in the meantime.

When not busy contemplating yuletide feats, Xanthopoulos and Horowitz pursue research into Einstein's Theory of General Relativity, which seeks to explain the behavior of objects in gravitational fields.

"We still don't know how to describe the fields about a rotating star," Xanthopoulos states, "though there have been some solutions for special cases. I've been looking for more general solutions to Einstein's equations." So far, such solutions elude him but he <u>has</u> developed a method for finding additional solutions if he is given some initially. A native of Drama, Greece, he expects to receive his Ph.D. in Physics from the University next summer.

Horowotz's research sounds nearly as exotic as the Santa problem. He is concerned with "naked singularities", mysterious phenomena that might

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occur if a massive star collapsed without becoming a black hole. The question before him is, "Can naked singularities form at all, and if not, why not?" Horowitz, who comes from Silver Spring, Maryland, has studied the problem for two years.

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