

Media contacts:

Judy Jackson, Fermilab, 630-840-3351, jjackson@fnal.gov

Kurt Riesselmann, Fermilab, 630-840-5681, kurtr@fnal.gov

Fermilab physicists discover “triple-scoop” baryon

Three-quark particle contains one quark from each family

Batavia, Ill.—Physicists of the DZero experiment at the Department of Energy’s Fermi National Accelerator Laboratory have discovered a new heavy particle, the Ξ_b (pronounced “zigh sub b”) baryon, with a mass of 5.774 ± 0.019 GeV/c², approximately six times the proton mass. The newly discovered electrically charged Ξ_b baryon, also known as the “cascade b,” is made of a down, a strange and a bottom quark. It is the first observed baryon formed of quarks from all three families of matter. Its discovery and the measurement of its mass provide new understanding of how the strong nuclear force acts upon the quarks, the basic building blocks of matter.

The DZero experiment has reported the discovery of the cascade b baryon in a paper submitted to Physical Review Letters on June 12.

“Knowing the mass of the cascade b baryon gives scientists information they need in order to develop accurate models of how individual quarks are bound together into larger particles such as protons and neutrons,” said physicist Robin Staffin, Associate Director for High Energy Physics for the Department of Energy’s Office of Science.

The cascade b is produced in high-energy proton-antiproton collisions at Fermilab’s Tevatron. A baryon is a particle of matter made of three fundamental building blocks called quarks. The most familiar baryons are the proton and neutron of the atomic nucleus, consisting of up and down quarks. Although protons and neutrons make up the majority of known matter today, baryons composed of heavier quarks, including the cascade b, were abundant soon after the Big Bang at the beginning of the universe.

The Standard Model elegantly summarizes the basic building blocks of matter, which come in three distinct families of quarks and their sister particles, the leptons. The first family contains the up and down quarks. Heavier charm and strange quarks form the second family, while the top and bottom, the heaviest quarks, make the third. The strong force binds the quarks together into larger particles, including the cascade b baryon. The cascade b fills a missing slot in the Standard Model.

Prior to this discovery, only indirect evidence for the cascade b had been reported by experiments at the Large Electron-Positron collider at the CERN Laboratory near Geneva, Switzerland. For the first time, the DZero experiment has positively identified the cascade b baryon from its decay daughter particles in a remarkably complex feat of detection. Most of the particles produced in high-energy collisions are short-lived and decay almost instantaneously into lighter stable particles. Particle detectors such as DZero measure these stable decay products to discover the new particles produced in the collision.

Once produced, the cascade b travels several millimeters at nearly the speed of light before the action of the weak nuclear force causes it to disintegrate into two well-known particles called J/ψ (“jay-sigh”) and Ξ^- (“zigh minus”). The J/ψ then promptly decays into a pair of muons, common particles that are cousins of electrons. The Ξ^- baryon, on the other hand, travels several centimeters before decaying into yet another unstable particle called a Λ (“lambda”) baryon, along with another long-lived particle called a pion. The Λ baryon too can travel several centimeters before ultimately decaying to a proton and a pion. Sifting through data from trillions of collisions produced over the last five years to identify these final decay products, DZero physicists have detected 19 cascade b candidate events. The odds of the observed signal being due to something other than the cascade b are estimated to be one in 30 million.

DZero is an international experiment of about 610 physicists from 88 institutions in 19 countries. It is supported by the Department of Energy, the National Science Foundation, and a number of international funding agencies. Fermilab is a national laboratory funded by the Office of Science of the U.S. Department of Energy, operated under contract by Fermi Research Alliance, LLC.

Notes for editors

InterAction Collaboration media contacts:

Institute of High Energy Physics, Beijing, Peoples Republic of China: + 86 10 88233105, xutz@mail.ihep.ac.cn

DAPNIA CEA-Saclay, France: Yves Sacquin, + 33 01 69 08 60 81, sacquin@dapnia.cea.fr

IN2P3-CNRS, France: Alain de Bellefon, + 33 01 44 96 47 51, bellefon@in2p3.fr

NIKHEF, Netherlands: Gabby Zegers, + 31 20 592 5075, gabbyz@nikhef.nl

Joint Institute for Nuclear Research, Dubna, Russia: Boris Starchenko, + 7 096 221 6 38 24, irinak@jinr.ru

Particle Physics and Astronomy Research Council (PPARC), United Kingdom: Peter Barratt, + 44 (0) 1793 442025, + 44 (0) 787 602 899 (mobile), peter.barratt@pparc.ac.uk

Lawrence Berkeley National Laboratory, California, USA: Lynn Yarris, +1-510-486-5375, LCYarris@lbl.gov

DZero collaborating institutions:

Universidad de Buenos Aires, Buenos Aires, Argentina

LAFEX, Centro Brasileiro de Pesquisas Fisicas, Rio de Janeiro, Brazil

Universidade do Estado do Rio de Janeiro, Rio de Janeiro, Brazil

Instituto de Fisica Teorica, Universidade Estadual Paulista, Sao Paulo, Brazil

University of Alberta, McGill University, Simon Fraser University and York University, Canada
University of Science and Technology of China, Hefei, People's Republic of China
Universidad de los Andes, Bogota, Colombia
Charles University, Center for Particle Physics, Prague, Czech Republic
Czech Technical University, Prague, Czech Republic
Institute of Physics, Academy of Sciences, Center for Particle Physics, Prague, Czech Republic
Universidad San Francisco de Quito, Quito, Ecuador
Laboratoire de Physique Corpusculaire, IN2P3-CNRS, Universite Blaise Pascal, Clermont-Ferrand, France
Laboratoire de Physique Subatomique et de Cosmologie, IN2P3-CNRS, Universite de Grenoble, Grenoble, France
CPPM, IN2P3-CNRS, Universite de la Mediterranee, Marseille, France
Laboratoire de l'Accelerateur Lineaire, IN2P3-CNRS et Universite Paris-Sud, Orsay, France
LPNHE, Universites Paris VI and VII, IN2P3-CNRS, Paris, France
DAPNIA/Service de Physique des Particules, CEA, Saclay, France
IPHC, IN2P3-CNRS, Universite Louis Pasteur Strasbourg, and Universite de Haute Alsace, France
Institut de Physique Nucleaire de Lyon, IN2P3-CNRS, Universite Claude Bernard, Villeurbanne, France
RWTH Aachen, III. Physikalisches Institut A, Aachen, Germany
Universitat Bonn, Physikalisches Institut, Bonn, Germany
Universitat Freiburg, Physikalisches Institut, Freiburg, Germany
Universitat Mainz, Institut fur Physik, Mainz, Germany
Ludwig-Maximilians-Universitat Munchen, Munchen, Germany
Fachbereich Physik, University of Wuppertal, Wuppertal, Germany
Panjab University, Chandigarh, India
Delhi University, Delhi, India
Tata Institute of Fundamental Research, Mumbai, India
University College Dublin, Dublin, Ireland
Korea Detector Laboratory, Korea University, Seoul, Korea
SungKyunKwan University, Suwon, Korea
CINVESTAV, Mexico City, Mexico
FOM-Institute NIKHEF and University of Amsterdam/NIKHEF, Amsterdam, The Netherlands
Radboud University Nijmegen/NIKHEF, Nijmegen, The Netherlands
Joint Institute for Nuclear Research, Dubna, Russia
Institute for Theoretical and Experimental Physics, Moscow, Russia
Moscow State University, Moscow, Russia
Institute for High Energy Physics, Protvino, Russia
Petersburg Nuclear Physics Institute, St. Petersburg, Russia
Lund University, Royal Institute of Technology, Stockholm University, and Uppsala University, Sweden
Lancaster University, Lancaster, United Kingdom
Imperial College, London, United Kingdom
University of Manchester, Manchester, United Kingdom
University of Arizona, Tucson, Arizona 85721, USA
Lawrence Berkeley National Laboratory and University of California, Berkeley, California

94720, USA

California State University, Fresno, California 93740, USA
University of California, Riverside, California 92521, USA
Florida State University, Tallahassee, Florida 32306, USA
Fermi National Accelerator Laboratory, Batavia, Illinois 60510, USA
University of Illinois at Chicago, Chicago, Illinois 60607, USA
Northern Illinois University, DeKalb, Illinois 60115, USA
Northwestern University, Evanston, Illinois 60208, USA
Indiana University, Bloomington, Indiana 47405, USA
University of Notre Dame, Notre Dame, Indiana 46556, USA
Purdue University Calumet, Hammond, Indiana 46323, USA
Iowa State University, Ames, Iowa 50011, USA
University of Kansas, Lawrence, Kansas 66045, USA
Kansas State University, Manhattan, Kansas 66506, USA
Louisiana Tech University, Ruston, Louisiana 71272, USA
University of Maryland, College Park, Maryland 20742, USA
Boston University, Boston, Massachusetts 02215, USA
Northeastern University, Boston, Massachusetts 02115, USA
University of Michigan, Ann Arbor, Michigan 48109, USA
Michigan State University, East Lansing, Michigan 48824, USA
University of Mississippi, University, Mississippi 38677, USA
University of Nebraska, Lincoln, Nebraska 68588, USA
Princeton University, Princeton, New Jersey 08544, USA
State University of New York, Buffalo, New York 14260, USA
Columbia University, New York, New York 10027, USA
University of Rochester, Rochester, New York 14627, USA
State University of New York, Stony Brook, New York 11794, USA
Brookhaven National Laboratory, Upton, New York 11973, USA
Langston University, Langston, Oklahoma 73050, USA
University of Oklahoma, Norman, Oklahoma 73019, USA
Oklahoma State University, Stillwater, Oklahoma 74078, USA
Brown University, Providence, Rhode Island 02912, USA
University of Texas, Arlington, Texas 76019, USA
Southern Methodist University, Dallas, Texas 75275, USA
Rice University, Houston, Texas 77005, USA
University of Virginia, Charlottesville, Virginia 22901, USA
University of Washington, Seattle, Washington 98195, USA