Particle smasher may reveal extra dimensions

by World-Science

When the worldâ€™s most powÂ-erÂ-ful parÂ-tÂ-iÂ-cle smashÂ-er starts up this sumÂ-mer, exÂ-otÂ-ic new parÂ-tÂ-iÂ-cles may ofÂ-fer a glimpse of the exÂ-istÂ-ence and shapes of exÂ-tra diÂ-menÂ-sions, says a group of physÂ-iÂ-cists.ExÂ-tra diÂ-menÂ-sions are a preÂ-dicÂ-tion of string theÂ-oÂ-ry, a modÂ-el of the unÂ-iverse popÂ-uÂ-lar among some sciÂ-enÂ-tists that deÂ-scribes naÂ-tureâ€™s funÂ-daÂ-menÂ-tal parÂ-tÂ-iÂ-cles as tiÂ-ny viÂ-bratÂ-ing threads of enÂ-erÂ-gy.

Engineers check the electronics at the Large Hadron Collider (Image courtesy CERN)

String theÂ-oÂ-ry ofÂ-fers relÂ-aÂ-tively simÂ-ple exÂ-planaÂ-tÂ-ions for disÂ-parÂ-ate pheÂ-nomÂ-eÂ-na and claims to reÂ-veal hidÂ-den unÂ-Â-iÂ-ties among naÂ-tureâ€™s forcÂ-es. But mathÂ-eÂ-matÂ-icÂ-ally, it all works out only if you add six or sevÂ-en exÂ-tra diÂ-menÂ-sions of space inÂ-to the equaÂ-tÂ-ions, beÂ-yond the three faÂ-milÂ-iar ones. ExÂ-plainÂ-ing the apÂ-parÂ-ent inÂ-visÂ-iÂ-bilÂ-ity of these diÂ-menÂ-sions beÂ-yond, theÂ-oÂ-rists say theyâ€™re curled up inÂ-to tiÂ-ny spaces.In a new stuÂ-dy, reÂ-searchÂ-ers say the tellÂ-tale sigÂ-naÂ-tures of a new class of subÂ-aÂ-tomÂ-ic parÂ-tÂ-iÂ-cles could help test these ideÂ-as and disÂ-tinÂ-guish beÂ-tween posÂ-siÂ-ble shapes of the diÂ-menÂ-sions.Much as a muÂ-siÂ-cal inÂ-struÂ-menÂ-tâ€™s shape deÂ-terÂ-mines its sound, the shape of these diÂ-menÂ-sions deÂ-terÂ-mines the propÂ-erÂ-ties and beÂ-havÂ-ior of our viÂ-sible unÂ-iverseâ€”with its three space diÂ-menÂ-sions plus one time diÂ-menÂ-sion, said physÂ-iÂ-cist Gary Shiu of the UniÂ-versÂ-ity of WisÂ-conÂ-sin-MadÂ-isÂ-on.â€œThe shape of the diÂ-menÂ-sions is cruÂ-cial beÂ-cause, in string theÂ-oÂ-ry, the way the string viÂ-brates deÂ-terÂ-mines the patÂ-tern of parÂ-tÂ-iÂ-cle massÂ-es and the forcÂ-es that we feel,â€• said Shu, lead auÂ-thor of a paÂ-per on the subÂ-ject in the Jan. 25 isÂ-sue of the reÂ-search jourÂ-nal PhysÂ-iÂ-cal ReÂ-view LetÂ-ters.PinÂ-ning down that shape should furÂ-ther our unÂ-derÂ-standÂ-ing and preÂ-dicÂ-tions of our four-diÂ-menÂ-sionÂ-al world, Shiu added. â€œThere are myrÂ-iÂ-ad posÂ-siÂ-bilÂ-iÂ-ties for the shapes of the exÂ-tra diÂ-menÂ-sions out there. It would be useÂ-ful to know a way to disÂ-tinÂ-guish one from anÂ-othÂ-er and perÂ-haps use exÂ-peÂ-riÂ-menÂ-tal daÂ-ta to narÂ-row downâ€• the posÂ-siÂ-bilÂ-iÂ-ties.Such exÂ-peÂ-riÂ-menÂ-tal evÂ-iÂ-dence could apÂ-pear in daÂ-ta from a new parÂ-tÂ-iÂ-cle acÂ-celÂ-erÂ-aÂ-tor, the Large HadÂ-ron ColÂ-lider, Shiu conÂ-tinÂ-ued. Itâ€™s schedÂ-uled to begÂ-in opÂ-erÂ-atÂ-ing latÂ-er this year near GeÂ-neÂ-va.An acÂ-celÂ-erÂ-aÂ-tor smashes atomÂ-ic nuÂ-clei head-on at nearly the speed of light, creÂ-atÂ-ing new, enÂ-erÂ-getÂ-ic and very unÂ-staÂ-ble parÂ-tÂ-iÂ-cles. These quickly disÂ-inÂ-teÂ-grate or â€œdeÂ-cayâ€• inÂ-to showÂ-ers of deÂ-tectÂ-aÂ-ble, lower-enÂ-erÂ-gy ones. CharÂ-acÂ-terÂ-isÂ-tic patÂ-terns of deÂ-cay serve as finÂ-gerÂ-prints of the fleetÂ-ing exÂ-otÂ-ic parÂ-tÂ-iÂ-cles and, posÂ-siÂ-bly, the shape of the unÂ-seen diÂ-menÂ-sions, Shiu exÂ-plained.With colÂ-leagues at his school and the UnÂ-iversÂ-ity of California-BerkeÂ-ley, Shiu proÂ-poses in the new study that the sigÂ-naÂ-ture patÂ-terns from parÂ-tÂ-iÂ-cles called Kaluza-Klein (KK) graviÂ-tons can disÂ-tinÂ-guish among difÂ-ferÂ-ent proÂ-posed â€œgeÂ-omeÂ-triesâ€• for exÂ-tra diÂ-menÂ-sions. How? Shiu comÂ-pares the efÂ-fect to a dark room where patÂ-terns of sound resÂ-oÂ-natÂ-ing off the walls can reÂ-veal the roomâ€™s shape. SimÂ-iÂ-larÂ-ly, KK graviÂ-tons are senÂ-siÂ-tive to the exÂ-tra-diÂ-menÂ-sionÂ-al shape and, through their beÂ-havÂ-ior and deÂ-cay, may reÂ-veal clues to that, he arÂ-gued. The new study shows that in simÂ-ulaÂ-tÂ-ions, even small geÂ-oÂ-metÂ-ric variaÂ-tÂ-ions lead to visÂ-iÂ-ble difÂ-ferÂ-ences in KK gravÂ-iÂ-ton sigÂ-naÂ-tures, said Bret UnÂ-derÂ-wood, a colÂ-league at ShiÂ-uâ€™s uniÂ-versÂ-ity.Based on this, Shiu said, â€œAt least in prinÂ-ciÂ-ple, one may be able to use exÂ-peÂ-riÂ-menÂ-tal daÂ-ta to test and conÂ-strain the geÂ-omÂ-eÂ-try of our unÂ-iverse.â€• Last year, Shiu and UnÂ-derÂ-wood reÂ-ported that clues to diÂ-menÂ-sionÂ-al geÂ-omeÂ-tries might alÂ-so be visÂ-iÂ-ble in patÂ-terns of radiaÂ-tÂ-ion left over from the Big Bang. The new work comÂ-pleÂ-ments the preÂ-viÂ-ous apÂ-proach, they say.â€œThe more hints we get, the betÂ-ter idea we have about the unÂ-derÂ-lyÂ-ing physics,â€• said Shiu. Added UnÂ-derÂ-wood, â€œIf the cosÂ-molÂ-oÂ-gy and parÂ-tÂ-iÂ-cle physÂ-ics daÂ-ta agree, itâ€™s an inÂ-dicaÂ-tÂ-ion weâ€™re on the right track.â€•

Courtesy University of Wisconsin-Madison and World Science staff

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