Paper takes swipe at bedrock law of physics

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A new paper by a self-described hobÂ-by physÂ-iÂ-cist chalÂ-lengÂ-es what may be the bedÂ-rock law of naÂ-ture. And while skepÂ-tics are rollÂ-ing their eyes, the study has apÂ-peared in a proÂ-fesÂ-sionÂ-al jourÂ-nal with the apÂ-paÂ-rent conÂ-sent of leadÂ-ing physiÂ-cists.

The principle under dispute, central to physics for at least two cenÂ-turÂ-ies, is called the law of conÂ-serÂ-vaÂ-tion of enÂ-erÂ-gy. It states that nothÂ-ing can be creÂ-atÂ-ed or deÂ-sÂ-tÂ-royed: you canâ€™t get someÂ-thing from noÂ-thÂ-ing, or vice-verÂ-sa, though conÂ-vertÂ-ing subÂ-sÂ-tanÂ-ces beÂ-tween diÂ-verse forms is very posÂ-siÂ-ble. A timeÂ-line showÂ-ing esÂ-tiÂ-maÂ-ted cosÂ-mic exÂ-panÂ-sion since the Big Bang. Right afÂ-ter that event, a suÂ-perÂ-heated, acÂ-celÂ-erÂ-atÂ-ing exÂ-panÂ-sion is beÂ-lieved to have takÂ-en place. It latÂ-er slowed down. In more reÂ-cent times, the speedup mysÂ-terÂ-iousÂ-ly reÂ-sumed. The tilted gray disk at apÂ-proxÂ-iÂ-mateÂ-ly the midÂ-dle of the figÂ-ure repÂ-reÂ-sents the preÂ-sÂ-ent. (CourÂ-teÂ-sy LawÂ-rence BerkÂ-eÂ-ley NaÂ-tioÂ-nÂ-al LaÂ-bÂ-oÂ-raÂ-toÂ-ry).But the paÂ-per claims new stuff may be formed conÂ-sÂ-tantÂ-ly, in one speÂ-cial setÂ-ting: withÂ-in black holes or siÂ-mÂ-iÂ-lar obÂ-jects. The idea, the authÂ-or adds, is tesÂ-tÂ-aÂ-ble and would reÂ-solve sevÂ-erÂ-al mysÂ-terÂ-ies, inÂ-cÂ-ludÂ-ing why the uniÂ-verse is exÂ-pandÂ-ing evÂ-er faster.â€œNot very plauÂ-siÂ-ble,â€• though not imÂ-posÂ-siÂ-ble, was how theÂ-oÂ-rÂ-eÂ-tÂ-iÂ-cal physÂ-iÂ-cist GaÂ-ry GibÂ-bons of the UniÂ-verÂ-siÂ-ty of CamÂ-bÂ-ridge, U.K., rated the proÂ-poÂ-sal.CosÂ-molÂ-oÂ-gist AnÂ-drei Linde of StanÂ-ford UniÂ-verÂ-siÂ-ty in StanÂ-ford, CaÂ-lif., deÂ-clared the paÂ-per nonÂ-sense nine miÂ-nÂ-utes afÂ-ter beÂ-ing eÂ-mailed a copy. At â€œfirst glance,â€• he wrote back, it â€œdoes not make any sense.â€• But asked to specÂ-iÂ-fy its erÂ-rors, he deÂ-clined. The overÂ-ridÂ-ing probÂ-lem, he wrote, was not mistakes, but an overÂ-all amÂ-aÂ-teurÂ-ishÂ-ness. â€œSorry for beÂ-ing so neÂ-gaÂ-tive,â€• but the stuÂ-dy is â€œnot evÂ-en wrong,â€• he wroteâ€”quoÂ-tÂ-ing a stingÂ-ing phrase sciÂ-enÂ-tÂ-ists someÂ-times use to disÂ-miss abÂ-surd findÂ-ings.Yet a note pubÂ-lished with the paÂ-per, in the jourÂ-nal New AsÂ-tronÂ-oÂ-my this month, inÂ-diÂ-catÂ-ed it had sucÂ-cessÂ-fulÂ-ly passed the scruÂ-tiÂ-ny of at least one emiÂ-nentÂ-ly quaÂ-liÂ-fied schoÂ-lar: co-editor JoÂ-seph Silk, head of the UniÂ-verÂ-siÂ-ty of OxÂ-ford, U.K., asÂ-troÂ-physÂ-ics deÂ-partÂ-ment. That â€œdoes make one wonÂ-der moreâ€• about the work, voÂ-lunÂ-teered Saul PerlÂ-mutÂ-ter of the UniÂ-verÂ-siÂ-ty of CalÂ-iÂ-forÂ-nia, BerkeÂ-ley, one of the acÂ-kÂ-nowÂ-ledged discoÂ-verÂ-ers of the acÂ-celÂ-erÂ-atÂ-ed cosÂ-mic exÂ-panÂ-sion. He deÂ-clined to comÂ-ment more on the paÂ-per, though, sayÂ-ing it wasÂ-nâ€™t exÂ-actÂ-ly in his field. Silk alÂ-so deÂ-clined.As standÂ-ard pracÂ-tice dicÂ-tates, New AsÂ-tronÂ-oÂ-my acÂ-ceptÂ-ed the paÂ-per onÂ-ly afÂ-ter an edÂ-iÂ-torâ€”Silkâ€”reÂ-viewed it in conÂ-sulÂ-taÂ-tion with an anonÂ-yÂ-mous outÂ-side exÂ-pert, the auÂ-thor said. Most sciÂ-enÂ-tists say a stuÂ-dyâ€™s acÂ-ceptÂ-ance for pubÂ-liÂ-caÂ-tion in a â€œpeer-reviewedâ€• reÂ-search jourÂ-nal, as New AsÂ-tronÂ-oÂ-my is, is a mark that it conÂ-stiÂ-tutes seÂ-riÂ-ous sciÂ-ence. This, of course, doesÂ-nâ€™t at all prove a study corÂ-rect. MoreÂ-oÂ-ver, not all peer-reviewed jourÂ-nals commaÂ-nd equal reÂ-spect among sciÂ-enÂ-tists, and New AsÂ-tronÂ-oÂ-my isnâ€™t conÂ-siÂ-dered the cream of the crop. ThomÂ-son SciÂ-enÂ-tiÂ-fÂ-ic, a PhiÂ-laÂ-delÂ-phia-based orÂ-ganÂ-iÂ-zaÂ-tion, ratÂ-ed it as the 16th most inÂ-fluÂ-enÂ-tial of 43 asÂ-tronÂ-oÂ-my and asÂ-troÂ-physÂ-ics jourÂ-nals worldÂ-wide pubÂ-lishÂ-ing new reÂ-search last year. Its edÂ-iÂ-toÂ-riÂ-al board inÂ-cludes, alongÂ-side Silk, reÂ-searchÂ-ers with the UniÂ-verÂ-siÂ-ty of CamÂ-bÂ-ridge, HarÂ-vard UniÂ-verÂ-sity and the Harvard-Smithsonian CenÂ-ter for AsÂ-troÂ-physÂ-ics.For the auÂ-thor, GregÂ-or BayÂ-er of CeÂ-dar Hill, TexÂ-as, the pubÂ-liÂ-caÂ-tion was a breakÂ-through. â€œIt has been a very hard strugÂ-gle for me to get anÂ-ything pubÂ-lished,â€• he wrote in an eÂ-mail, though he had anÂ-othÂ-er paÂ-per in print earÂ-liÂ-er this year. â€œForÂ-tuÂ-nately, some good peoÂ-ple are beÂ-ginÂ-ning to take me seÂ-riÂ-ously.â€•BayÂ-er atÂ-tribÂ-utÂ-ed his

trouÂ-bles to the fact that he doesnâ€™t work for any sciÂ-enÂ-tiÂ-fic inÂ-stiÂ-tuÂ-tion, so othÂ-er reÂ-searchÂ-ers are reÂ-lucÂ-tant to back his theÂ-oÂ-ries. â€œI have a Ph.D. in physÂ-ics from the UniÂ-verÂ-siÂ-ty of ChicaÂ-go,â€• from 1972, he wrote; â€œbut I left the field maÂ-ny years ago. As a caÂ-reer, physÂ-ics is hell: as a hobÂ-by, it is heavÂ-en. Ideas come easÂ-iÂ-ly to me now.â€•BayÂ-erâ€™s paÂ-per on energy conÂ-serÂ-vaÂ-tion conÂ-siÂ-ders black holes, stuÂ-penÂ-dousÂ-ly dense ceÂ-lesÂ-tial boÂ-dies that pack so much weight inÂ-to so litÂ-tle space that their gravÂ-iÂ-ty overÂ-powÂ-ers evÂ-erything nearÂ-by, inÂ-cludÂ-ing light rays. ConÂ-diÂ-tions in black holes are thought to mimÂ-ic in some ways those preÂ-vailÂ-ing at the orÂ-iÂ-gin of the uniÂ-verse. Then, sciÂ-enÂ-tists beÂ-lieve, all matÂ-ter was packed inÂ-to a point; this then exÂ-plodÂ-ed in a â€œBig Bang,â€• spawnÂ-ing the cosÂ-mos.If a black hole had an opÂ-poÂ-site, it would be what physÂ-iÂ-cists call vacÂ-uÂ-um. In plain terms, that means nothÂ-ingÂ-ness, though this word is misÂ-leadÂ-ing beÂ-cause some minÂ-iÂ-mal levÂ-el of acÂ-tivÂ-iÂ-ty has been found to unÂ-fold even in the empÂ-tiest space.VacÂ-uÂ-um is ubiqÂ-uiÂ-tous. Even in solÂ-id obÂ-jects, there is plenÂ-ty of room for vacÂ-uÂ-um, beÂ-tween and inÂ-side the atoms. In a black hole, vacÂ-uÂ-um could alÂ-so conÂ-ceivÂ-aÂ-bly find lodgÂ-ings. But there, the crampÂ-ing might beÂ-come sevÂ-ere even for a guest of such modÂ-est demaÂ-ndsâ€”forcÂ-ing the vacÂ-uÂ-um, in BayÂ-erâ€™s view, to lead a preÂ-carÂ-iÂ-ous exÂ-istÂ-ence.WithÂ-in black holes or siÂ-mÂ-iÂ-lar obÂ-jects, he arÂ-gues, exÂ-treme conÂ-diÂ-tions may inÂ-ject â€œinÂ-staÂ-bilÂ-iÂ-tyâ€• inÂ-to the vacÂ-uÂ-um, conÂ-vertÂ-ing parts of it inÂ-to non-vacÂ-uÂ-um, or matÂ-ter. â€œMatÂ-ter creÂ-aÂ-tion can be said to arise from some new parÂ-tiÂ-cle inÂ-terÂ-acÂ-tion which viÂ-oÂ-lates enÂ-erÂ-gy conÂ-serÂ-vaÂ-tion,â€• he wrote in an email.GibÂ-bons is unÂ-conÂ-vinced. BayÂ-er fails to clarÂ-iÂ-fy â€œthe dyÂ-namÂ-ics beÂ-hindâ€• the proÂ-cess, he wrote, adding that standÂ-ard parÂ-tiÂ-cle physÂ-ics alÂ-ready ofÂ-fers a well-supÂ-portÂ-ed acÂ-count of how mass arises, called the Higgs mechÂ-anÂ-ism. BayÂ-er arÂ-gued that some vagueÂ-ness in his acÂ-count is inÂ-eÂ-viÂ-taÂ-ble, beÂ-cause reÂ-searchÂ-ers are still â€œtryÂ-ing to figÂ-ure out what the vacÂ-uÂ-um realÂ-ly is.â€• But he claims matÂ-ter creÂ-aÂ-tion could exÂ-plain the acÂ-celÂ-erÂ-atÂ-ing exÂ-panÂ-sion of the uniÂ-verse, which PerlÂ-mutÂ-ter and othÂ-ers idenÂ-tiÂ-fied in the late 1990s. Why the speedup ocÂ-curs is one of the most vexÂ-ing scientifÂ-ic mysÂ-terÂ-ies of the past decÂ-ade. AsÂ-troÂ-noÂ-mers proÂ-viÂ-sionÂ-alÂ-ly atÂ-tribÂ-ute it to a yet-to-be-iÂ-denÂ-tiÂ-fied â€œdark enÂ-erÂ-gy,â€• whose naÂ-ture reÂ-mains unÂ-known.BayÂ-erâ€™s exÂ-plaÂ-naÂ-tion of this links matÂ-ter creÂ-aÂ-tion to anothÂ-er conÂ-cept, presÂ-sure, a measÂ-ure of how much a givÂ-en blob of matÂ-ter is â€œsqueezedâ€• by whatâ€™s around it. Itâ€™s why your head hurts if you dive deepÂ-ly. NegÂ-aÂ-tive presÂ-sure is alÂ-so conÂ-ceivÂ-ableâ€”your head beÂ-ing pulled apartâ€”though we nevÂ-er exÂ-peÂ-riÂ-ence this on Earth.A simÂ-pliÂ-fied view is that posÂ-iÂ-tive presÂ-sure is an air hose blowÂ-ing outÂ-ward; negÂ-aÂ-tive presÂ-sure, a vacÂ-uÂ-um cleanÂ-er suckÂ-ing inÂ-ward.EinÂ-stein deÂ-terÂ-mined that an obÂ-jecÂ-tâ€™s gravÂ-iÂ-ty deÂ-pends not just on its mass, as was known beÂ-fore, but its presÂ-sure. If an obÂ-ject has enough negÂ-aÂ-tive presÂ-sure, its gravÂ-iÂ-ty can alÂ-so beÂ-come negÂ-aÂ-tive, and hence reÂ-pulÂ-sive rathÂ-er than atÂ-tracÂ-tive.BayÂ-er arÂ-gued that matÂ-ter creÂ-aÂ-tion is asÂ-soÂ-ciÂ-atÂ-ed with reÂ-pulÂ-sive gravÂ-iÂ-ty beÂ-cause itâ€™s alÂ-so linked to negÂ-aÂ-tive presÂ-sure. â€œThe flow of enÂ-erÂ-gy inÂ-to the UniÂ-verse can be deÂ-scribed as beÂ-ing caused by an exÂ-terÂ-nal presÂ-sure from the vacÂ-uÂ-um,â€• he wrote in an email. â€œViewed from inÂ-side the UniÂ-verse, the posÂ-iÂ-tive exÂ-terÂ-nal presÂ-sure looks like a negÂ-aÂ-tive inÂ-terÂ-nal presÂ-sure.â€•BringÂ-ing back the air-hose analÂ-oÂ-gy, imÂ-agÂ-ine an inÂ-visÂ-iÂ-ble hose blowÂ-ing air outÂ-ward and inÂ-to the mouth of a secÂ-ond tube. That secÂ-ond pipe would apÂ-pear as though it were suckÂ-ing in airâ€”negÂ-aÂ-tive presÂ-sure.NegÂ-aÂ-tive presÂ-sure withÂ-in leÂ-gions of black holes would creÂ-ate a gravÂ-iÂ-taÂ-tionÂ-al reÂ-pulÂ-sion that perÂ-meÂ-ates the cosÂ-mos and pushes it outÂ-ward reÂ-lentÂ-lessÂ-ly, BayÂ-er claims. â€œWhile matÂ-ter is beÂ-ing creÂ-atÂ-ed, there is a gravÂ-iÂ-taÂ-tionÂ-al reÂ-pulÂ-sion asÂ-soÂ-ciÂ-atÂ-ed with the enÂ-erÂ-gy flow. When the flow stops, onÂ-ly the orÂ-diÂ-nary gravÂ-iÂ-taÂ-tionÂ-al atÂ-tracÂ-tion of the creÂ-atÂ-ed mass reÂ-mains.â€• All newÂ-ly minted mass would reÂ-side permaÂ-nently in its home black hole.MatÂ-ter creÂ-aÂ-tion would equate to enÂ-erÂ-gy creÂ-aÂ-tion beÂ-cause, as EinÂ-stein found with the famed equaÂ-tion E=mc2, matÂ-ter and enÂ-erÂ-gy are two forms of the same thing.Whatever you call it, BayÂ-er said the creation proÂ-cess could exÂ-pÂ-lain not onÂ-ly the dark enÂ-erÂ-gy puzÂ-zle but an arÂ-ray of othÂ-ers: the idenÂ-tiÂ-ty of the â€œdark matÂ-terâ€• that makes up five-sixths of the maÂ-teÂ-riÂ-al in the cosÂ-mos,

but is unÂ-seen; why cerÂ-tain cosÂ-mic rays hit Earth with othÂ-erwise inÂ-exÂ-pliÂ-caÂ-bly high enÂ-erÂ-gies; and what caused an â€œinÂ-flaÂ-tionâ€• beÂ-lieved to have made the uniÂ-verse grow stuÂ-penÂ-dousÂ-ly big withÂ-in a fracÂ-tion of a secÂ-ond afÂ-ter the Big Bang.CosÂ-molÂ-oÂ-gists beÂ-lieve acÂ-celÂ-erÂ-atÂ-ed swellÂ-ing of the cosÂ-mos ocÂ-curred durÂ-ing two sepÂ-aÂ-rate peÂ-riÂ-ods: durÂ-ing the inÂ-flaÂ-tion epÂ-och, and more reÂ-centÂ-ly. BayÂ-er says thatâ€™s beÂ-cause both episodes witÂ-nessed matÂ-ter creÂ-aÂ-tion. The speedup stopped in beÂ-tween, he arÂ-gues, beÂ-cause inÂ-iÂ-tial forÂ-maÂ-tion of the uniÂ-verse was over, but black holes werenâ€™t formed yet.Yet Linde, a foundÂ-er of the inÂ-flaÂ-tion theÂ-oÂ-ry, disÂ-agrees. BayÂ-er said his theÂ-oÂ-ry of enÂ-erÂ-gy non-conservation could be tested usÂ-ing parÂ-tiÂ-cle acÂ-celÂ-erÂ-aÂ-tors, which bash subÂ-aÂ-tomÂ-ic parÂ-tiÂ-cles toÂ-geÂ-ther to help see what theyâ€™re made of. NorÂ-malÂ-ly, conservaÂ-tion of enÂ-erÂ-gy is used to calÂ-cuÂ-late propÂ-erÂ-ties of the parÂ-tiÂ-cles flyÂ-ing out of the bang-up. But the law is asÂ-sumed, rathÂ-er than provÂ-en, in these exÂ-perÂ-iÂ-ments, BayÂ-er arÂ-gued. â€œA seÂ-riÂ-ous test of enÂ-erÂ-gy conservaÂ-tion in high-enÂ-erÂ-gy colÂ-liÂ-sions will reÂ-quire careÂ-ful analÂ-yÂ-sis of maÂ-ny comÂ-plex multi-parÂ-tiÂ-cle events,â€• he wrote in his paper. This would be hard, he adÂ-ded, but it can be done.

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