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| **FINAL -- 6 February** | **Translation** |
| **Phantom of the Universe: The Hunt for Dark Matter** | **Universumi fantoom: tumeaine otsinguil** |
| [00:03]  As we look out, into the night sky, we are both dazzled and comforted by the patches of light we find there: stars, planets, galaxies, and the moon.  [00:25] | [00:03]  Pimedasse öötaevasse vaadates näeme seal ammusest ajast tuttavad kaaslasi: tähti, planeete, galaktikaid ja Kuud.  [00:25] |
| [00:34]  But, as instruments became more advanced, astronomers began to suspect there was something more out there – something hiding… in the dark spaces.  [00:45] | [00:34]  Kuid mida tundlikumaks ja täpsemaks muutusid vaatlusinstrumendid, seda enam hakkas teadlastele tunduma, et kosmose pimeduses peitub veel midagi.  [00:45] |
| [00:47]  We can’t see it, feel it or touch it… but it’s there.  [00:53] | [00:47]  Midagi, mida ei saa näha, tunnetada ega katsuda.  [00:53] |
| [00:59]  It doesn’t emit light or reflect it.It’s a substance so mysterious, there’s only one way to describe it: dark matter.  [01:12] | [00:59]  See ei kiirga ega peegelda valgust ning seetõttu on see salapärane aine saanud nimeks tumeaine.  [01:12] |
| [01:15]  It’s so massive, its gravitational pull influences the brightest and most colossal objects in space.  [01:23] | [01:15]  Seda on nii palju, et selle raskusjõud mõjutab Universumi kõige heledamaid ja suuremaid struktuure…  [01:23] |
| [01:24]  It’s so powerful, it can change the course of light itself.  [01:30] | [01:24]  … ning kallutab oma teelt kõrvale isegi valguse.  [01:30] |
| [01:37]  It’s a humbling reminder that there’s more to this universe than meets the eye.  [01:43] | [01:37]  Tumeaine on hea näide sellest, et meie Uni­versum on keerukam, kui esmapilgul paistab.  [01:43] |
| [01:45]  In order to understand this mysterious substance, physicists on Earth are hunting down a very elusive particle they believe exists in the subatomic world.  [01:56] | [01:45]  Selle salapärase aine paremaks mõistmiseks on teadlased asunud otsima uut saladuslikku algosakest, mille olemasolu võiks tumeaine olemust selgitada.  [01:56] |
| [02:05]  This is CERN, the European Center for the Study of Particle Physics.  [02:10] | [02:05]  See on CERN – Euroopa osakestefüüsika uurimise keskus ning siin asub maailma suurim osakestekiirendi – Suur Hadronite Põrguti.  [02:17] |
| [02:11]  It’s the home of the world’s largest particle accelerator, the Large Hadron Collider. [02:17] |
| [02:19]  Hidden deep underground, the Large Hadron Collider is the only place on Earth powerful enough to bring this mystery particle into existence.  [02:28] | [02:19]  See sügavale maa alla rajatud kiirendi on ainus piisavalt võimas seade Maal, mis võiks suuta salapärase tumeaine osakese esile kutsuda.  [02:28] |
| [02:30]  At 27 kilometers in circumference – that’s 17 miles -- it straddles the border between France and Switzerland.  [02:39] | [02:30]  27-kilomeetrise ümbermõõduga rõngakujuline kiirendi asub Šveitsi ja Prantsusmaa piiril.  [02:39] |
| [02:41]  As we enter the accelerator tunnel, we’ll experience -- first-hand --the fastest chase scene on Earth.  [02:48] | [02:41]  Kiirendi tunnelisse sisenedes saame näha kõige kiiremat võiduajamist meie planeedil.  [02:48] |
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| [03:04]  Here, inside the beam pipe, particles called protons are pushed to velocities approaching the speed of light.  [03:11] | [03:04]  Siin, kiiretoru sisemuses sunnitakse prootonite-nimelisi osakesi liikuma valguse kiiruse lähedase kiirusega…  [03:11] |
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| [03:17]  Some of them will smash into *other* protons racing straight toward them.  [03:20] | [03:17]  …ning osad neist põrkavad kokku teiste, vastassuunas kihutavate prootonitega.  [03:20] |
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| [03:25]  It’s all part ofthe hunt for a new kind of fundamental particle that forms *dark matter*.  [03:30] | [03:25]  Kõik see on osa uut tüüpi osakeste otsingu­test, mis võib-olla moodustavadki tumeaine.  [03:30] |
| [03:39]  Already the Large Hadron Collider has made an incredible discovery that lends weight to our story. Not that long ago there were fireworks at CERN on a recent Fourth of July as scientists announced the discovery of a particle called the Higgs boson.  [03:57] | [03:39]  Suur Hadronite Põrguti on juba teinud uskumatuna näiva avastuse, mis meie loo kaalukamaks muudab. Alles hiljuti tähistati CERNis suure tulevärgiga uue algosakese – Higgsi bosoni – avastamist.  [03:57] |
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| [03:58]  Physicists had searched for this particle for 50 years, ever since theorists showed that the source of the mass of all fundamental particles requires its presence. Particles like electrons and quarks get their mass when they pass through the Higgs Field, and so might the particle that makes up dark matter.  [04:20] | [03:58]  Seda osakest otsiti ligi 50 aastat, alates ajast, mil teoreetiline füüsika ennustas selle olemasolu kõigi osakeste massi põhjustajana.  Elektronid, kvargid ja muud osakesed omandavad massi läbi Higgsi välja liikudes ning samamoodi võivad seda teha ka tumeaine osakesed.  [04:20] |
| [04:23]  Now, the search at the Large Hadron Collider turns to finding the dark matter particle itself.  [04:28] | [04:23]  Nüüd ongi Suur Hadronite Põrguti keskendunud tumeaine osakeste endi leidmisele.  [04:28] |
| [04:33]  Astrophysicists have demonstrated that over 80% of the mass in the cosmos consists of dark matter  [04:41] | [04:33]  Vaatlustele tuginedes arvavad astronoomid, et tervelt 80% kogu Universumi massist koosneb tumeainest.  [04:41] |
| **[04:43] TITLE SEQUENCE [05:03]** | **[04:43] PEALKIRI [05:03]** |
| [04:47]  This is the amazing story of how we discovered that most of the matter in the universe is of an extraordinary, invisible type. [04:57] | [04:47]  Järgnev film räägib loo sellest, kuidas avastasime, et suurem osa Universumi ainest on erilist, meile nähtamatut sorti.  [04:57] |
| [05:05]  Dark matter has been around since the beginning of time… the very beginning…  [05:12] | [05:05]  Tumeaine on olnud olemas Universumi aegade algusest saati, sama kaua kui aeg ise.  [05:12] |
| **[05:13] BIG BANG EXPLOSION** | **[05:13] SUUR PAUK** |
| [05:14]  Our universe was born in the form of a hot dense frenzy of energy expanding at an incredible rate.  [05:21] | [05:14]  Meie Universum tekkis tiheda ja kuuma energiakogumina, mis paisus tohutu kiirusega suuremaks.  [05:21] |
| [05:25]  A tiny fraction of a second later, energy transformed into the first particles of our universe.  [05:32] | [05:25]  Sekundi kaduvväikese murdosa võrra hiljem tekkisid energiast Universumi esimesed osakesed.  [05:32] |
| [05:34]  Tiny particles called quarks formed protons and neutrons. These combined with electrons to create the first atoms. Atoms, in turn, make up regular matter, the substance of which, physical objects are made.  [05:49] | [05:34]  Pisikesed algosakesed, mida kutsutakse kvarkideks, moodustasid ühinedes prootonid ja neutronid. Koos elektronidega moodus­tasid need omakorda esimesed aatomid, millest koosnevad kõik meile tuntud objektid.  [05:49] |
| [05:52]  As conditions cooled and space expanded, *dark*matter’s mass coalesced into strands. These strands formed an invisible skeleton in space.  [06:06] | [05:52]  Suuremaks paisudes Universum jahtus ning tumeaine koondus kiududeks. Nendest kiududest moodus­tus kosmosesse nähtamatu võrgustik.  [06:06] |
| [06:08]  Over hundreds of millions of years, the gravity from dark matter’s mass was so powerful, it pulled regular mass to it, like meat to its ribs… and formed the sinewy structure of the universe.  [06:23] | [06:08]  Sadade miljonite aastate jooksul mõjutas tumeaine raskusjõud ka tavalist ainet, koondades seda enda ümber samamoodi nagu kasvab liha luudele. Nii moodustus ka tavalisest ainest käsnakujuline struktuur.  [06:23] |
| [06:33]  The first galaxies grew at the intersections of these filaments.  [06:37]. | [06:33]  Selle ainevõrgustiku sõlmedes arenesid välja esimesed galaktikad.  [06:37] |
| [06:41]  Galaxies collided with other galaxies… and merged again to form super-clusters of galaxies.  [06:47] | [06:41]  Moodustuvad galaktikad põrkusid üksteisega, moodustades suured galaktikaparved.  [06:47] |
| [06:48]  Countless galaxies were drawn together by dark matter’s pull…  [06:55] | [06:48]  Tumeaine tõmme koondas kokku loendamatu hulga galaktikaid,  [06:55] |
| [06:57]  … and from there, they grew into the structure of the universe we see today.  [07:01] | [06:57]  mis moodustasid lõpuks Universumi struktuuri, nagu seda tänapäeval näeme.  [07:01] |
| [07:02]  Without dark matter, there would be no stars, no galaxies, no planets, no life. Without dark matter, we ourselves would not exist.  [07:14] | [07:02]  Ilma tumeaineta poleks olemas tähti, galaktikaid, planeete ega elu. Ka meid poleks tumeaine abita olemas.  [07:14] |
| [07:17]  Dark matter lay hidden from human view for millennia until finally, traces of its influence became apparent to astronomers.  [07:24] | [07:17]  Tumeaine jäi aastatuhandeteks vaatluste eest varjatuks, kuni alles hiljuti hakkasid astronoomid selle mõju märkama.  [07:24] |
| **Fritz Zwicky** | **Fritz Zwicky** |
| [07:27]  The first was Fritz Zwicky, a Swiss astrono­mer, who worked at Cal Tech in the 1930’s.  [07:33] | [07:27]  Üks esimesi oli Fritz Zwicky – šveitsi astronoom, kes töötas 1930ndatel USAs California Tehnoloogiainstituudis.  [07:33] |
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| [07:35]  Zwicky turned his telescope toward a group of galaxies not too far from our own Milky Way. This swarming network of over a *thousand* galaxies is known as the Coma Cluster and Zwicky’s mission was to determine its mass.  [07:50] | [07:35]  Zwicky uuris teleskoobiga Coma galaktikaparve, mis paikneb Linnuteele üsna lähedal. See parv koosneb ligi tuhandest galaktikast ning Zwicky tahtis kindlaks määrata selle massi.  [07:50] |
| [07:51]  He could do this by measuring its brightness...  [07:54] | [07:51]  Seda saab teha, mõõtes parve heledust  [07:54] |
| [08:01]  ...and by measuring the speed of galaxies orbiting inside the cluster.  [08:06] | [08:01]  ... ja selles liikuvate galaktikate kiiruseid.  [08:06] |
| [08:13]  Zwicky discovered that the galaxies were moving much faster than he expected. [08:18] | [08:13]  Zwicky avastas, et galaktikad liiguvad oodatust palju kiiremini,  [08:18] |
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| [08:20]  Especially considering the amount of mass in the cluster as indicated by brightness.  [08:25] | [08:20]  võrreldes sellega, kui palju massi pidanuks parves olema selle heleduse järgi.  [08:25] |
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| [08:25]  At these speeds, the visible mass wasn't great enough to hold the cluster together. [08:30] | [08:25]  Galaktikad liikusid sedavõrd kiiresti, et nähtava massi raskusjõud ei suudaks parve koos hoida.  [08:30] |
| [08:32]  Zwicky theorized there must be some invisible substance lying in hiding holding the speeding galaxies into the cluster.  [08:41] | [08:32]  Zwicky oletas, et parv peab sisaldama mingisugust nähtamatut ainet, mis hoiab kihutavaid galaktikaid parve sees kinni.  [08:41] |
| [08:45]  He called the substance “dark matter.” [08:48] | [08:45]  Ta nimetas selle nähtamatu aine „tumeaineks“.  [08:48] |
| [08:50]  But some ideas are ahead of their time. [08:53] | [08:50]  Mõned ideed on aga oma ajast ees.  [08:53] |
| **Vera Rubin** | **Vera Rubin** |
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| [08:54]  Zwicky’s revolutionary findings went largely unnoticed until 40 years later when astronomer Vera Rubin started to study the orbital speeds of stars in galaxies. What she observed surprised and confounded her. [09:11] | [08:54]  Zwicky revolutsiooniline avastus jäi ligi 40 aastaks laiema tähelepanuta. Alles siis kui astronoom Vera Rubin hakkas uurima tähtede tiirlemiskiiruseid galaktikates, sai ta samasuguse üllatuse osaliseks.  [09:11] |
| [09:15]  According to Newton’s Law of Gravitation, the sun’s powerful mass creates a gravitational pull that causes the inner planets to travel at faster speeds than planets that are farther out.  [09:28] | [09:15]  Newtoni gravitatsiooniseaduse kohaselt tekitab Päikese suur mass gravitatsioonivälja, mis sunnib lähemal tiirlevaid planeete liikuma suurema kiirusega kui kaugemaid planeete.  [09:28] |
| [09:50]  Since stars orbit around a galaxy’s center much the way planets orbit the sun, Rubin thought she’d see similar speed patterns when she observed the nearby Andromeda Galaxy.  [10:01] | [09:50]  Tähed tiirlevad galaktika keskme ümber põhimõtteliselt samamoodi ning seetõttu arvas Rubin, et kiiruste jaotus peaks keskmest kaugenedes samasugune olema.  Meile lähedal asuvat Andromeeda galaktikat vaadeldes nägi ta aga midagi hoopis teistsugust.  [10:08] |
| [10:04]  But what she saw was radically different. [10:08] |
| [10:09]  Stars that were in orbit far from the galaxy’s center were whizzing along at high speeds, identical to the stars much closer in.  [10:18] | [10:09]  Galaktika keskmest kaugel tiirutasid tähed umbes sama kiiresti kui keskmele lähemad tähed.  [10:18] |
| [10:22]  This was not at all like the speeds of planets in our solar system, where the inner planets go much faster than the outer planets.  [10:29] | [10:22]  See oli drastiliselt erinev Päikesesüsteemist, kus lähemad planeedid liiguvad palju kiiremini kui kaugemad planeedid.  [10:29] |
| [10:32]  At these incredible speeds, without adequate gravitational pull from something massive, the stars should fly out of control and jettison out into space.  [10:47] | [10:32]  Vaadeldud kiiruste korral peaksid galaktika välispiirkodade tähed kosmosesse laiali lendama, kui neid miski koos ei hoia.  [10:47] |
| [10:49]  Something was keeping the galaxy together. What could it be?  [10:59] | [10:49]  Miski siiski hoiab Andromeeda galaktikat koos, kuid mis see olla võiks?  [10:59] |
| [11:02]  Rubin and her team concluded that there must be some strange, invisible mass that extended to the outer edges of the galaxy and beyond.  [11:11] | [11:02]  Rubin ja tema kolleegid järeldasid, et seal peaks olema mingi tundmatu ja nähtamatu aine, mis ulatub kaugemale kui galaktika nähtav välisserv.  [11:11] |
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| [11:14]  It was as if an invisible cloud held the stars together like a kind of glue.  [11:18] | [11:14]  Tundus, nagu hoiaks tähti koos mingi nähtamatust ainest pilv.  [11:18] |
| [11:19]  We can see visual evidence of these dark matter halos in other parts of the universe as well.  [11:25] | [11:19]  Selliste tumeaine halode olemasolule viitavad Universumis veel mitmed nähtused.  [11:25] |
| [11:31]  We see the most dramatic evidence for dark matter in a celestial structure astronomers refer to as “the Bullet Cluster.” **When astronomers looked closely at galaxies in the cluster, they saw subtle distortions caused by something invisible*.***  [11:47] | [11:31]  Üks kõige selgemaid tõendeid tumeaine olemasolu kohta asub galaktikaparves, mida astronoomid kutsuvad Bulleti – maakeeli „püssikuuli“ parveks. Parve lähemalt uurides on näha mingi nähtamatu aine tekitatud moonutused.  [11:47] |
| [11:48]  The suspect: dark matter.  [11:50 ] | [11:48]  Kahtlusaluseks on taaskord tumeaine.  [11:50] |
| [11:52]  Astronomers used an x-ray telescope in space to detect massive concentrations of hot interstellar gas whose bullet-like shapes give the cluster its name.  [12:03] | [11:52]  Röntgenkiirgust vaatlevate teleskoopidega tuvastasid astronoomid suured kuumad tähtedevahelise gaasi pilved, mille kuuli meenutav kuju andis parvele nime.  [12:03] |
| [12:04]  The Bullet Cluster was formed when two smaller clusters of galaxies collided.  [12:09] | [12:04]  See galaktikaparv on tekkinud kahe väiksema parve kokkupõrkel.  [12:09] |
| [12:10]  If we could travel back in time to before the collision, we’d see two distinct clusters, each enclosed in its own cloud of dark matter. [12:20] | [12:10]  Kui saaksime minna tagasi kokkupõrke-eelsesse aega, näeksime kahte eraldi parve, mõlemad omaenda tumeaine pilvega.  [12:20] |
| [12:21]  When the two galaxy clusterscollided, the dark matter clouds passed right through each other.  [12:27] | [12:21]  Kahe parve kokkupõrkel lendasid tumeainepilved otse teineteisest läbi.  [12:27] |
| [12:27]  The dense clouds of gas and dust shown in pink, however, crashed into one another toward the center.  [12:33] | [12:27]  Tihedad roosat värvi gaasi- ja tolmupilved põrkasid aga kokku ning koondusid keskele.  [12:33] |
| [12:58]  What is this dark matter that can pass right though a galactic collision without interacting with anything?  [13:03] | [12:58]  Mis on see müstiline tumeaine, mis suudab ilma mingi vastasmõjuta läbida terve galaktikaparvede kokkupõrke?  [13:03] |
| [13:05]  Because of this unique quality, a dark matter particle like this one travelling through space, won’t let anything stand in its way. [13:13] | [13:05]  Tumeaine osakestel puudub peaaegu igasugune vastasmõju tavalise ainega. Seepärast ei lasegi läbi kosmose rändav tumeaine osake ennast mitte milleski häirida.  [13:13] |
| LUX | LUX |
| [13:32]  Dark matter doesn’t exist only out in space; it’s everywhere…  [13:39] | [13:32]  Tumeainet pole vaid kosmoses, vaid seda on kõikjal.  [13:39] |
| [13:48]  Dark matter is all around us right now. [13:51] | [13:48]  Tumeaine ümbritseb praegu ka meid.  [13:51] |
| [13:55]  If you hold up your hand, millions of dark matter particles will pass through it within the next minute.  [14:01] | [13:55]  Kui tõstaksite oma käe praegu üles, läbib seda järgmise minuti jooksul miljoneid tumeaine osakesi.  [14:01] |
| [14:03]  Particles you can't see or feel. As a matter of fact, there are billions of different subatomic particles flying through this room as we speak.  [14:14] | [14:03]  Neid pole võimalik näha ega tunda. Ning need pole ainsad – igal ajahetkel läbib meie planetaariumi miljardeid algosakesi.  [14:14] |
| [14:19]  This is the entrance to the Homestake Mine in South Dakota. It’s the ultimate place to filter the dark matter particles out from the rest.  [14:28] | [14:19]  See on sissepääs Homestake’i kaevandusse USAs Lõuna-Dakota osariigis. See on parim koht maailmas, kus eristada tumeaine osakesi kõigi teiste hulgast.  [14:28] |
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| [14:30]  In order to isolate the dark matter particles, physicists conduct experiments deep under­ground where most ordinary particles can't travel, but dark matter particles easily *can.*  [14:43] | [14:30]  Tumeaine osakeste isoleerimiseks tehakse siin katseid sügaval maapõues, kuhu tavalised osakesed ei pääse. Tumeaine osakesed jõuavad siia aga ilma mingi vaevata.  [14:43] |
| [14:46]  Every morning, dozens of scientists travel down a giant elevator shaft 1500 meters underground -- that's almost a mile -- to work with the most sensitive dark matter detector in the world.  [15:00] | [14:46]  Igal hommikul sõidavad mitukümmend teadlast suure liftiga ligi pooleteise kilomeetri sügavusele maa alla, kus asub maailma kõige tundlikum tumeaine detektor.  [15:00] |
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| [15:01]  What they find in this sub-terrestrial labyrinth of abandoned mining tunnels could change the way we view the entire universe. [15:10] | [15:01]  Siin mahajäetud kaevanduskäikude maa-aluses labürindis tehtavad avastused võivad muuta meie arusaamu tervest Universumist.  [15:10] |
| [15:17]  This was once a thriving gold mine but now instead of miners mining for gold, the physicists who work here are mining for an even more elusive substance: dark matter. [15:28] | [15:17]  Vanasti oli see rikkalik kullakaevandus, kuid tänapäeval otsivad siin töötavad füüsikud midagi kullast veel haruldasemat – tumeainet.  [15:28] |
| [15:31]  This is the Sanford Underground Research Facility.  [15:34] | [15:31]  See on Sanfordi Maa-alune Uurimisasutus, kust leiame LUXi-nimelise eksperi­mendi. See on inglisekeelne lühend „Suurest maa-alusest ksenooni tumeaine eksperimendist“  [15:40] |
| [15:35]  It's here that we’ll find the Large Underground Xenon *Dark Matter* Experiment, or “LUX” for short.  [15:40] |
| [15:42]  This tank filled with liquid xenon will be the perfect theater for witnessing the first appearance of a dark matter particle. [15:50] | [15:42]  Loodetakse, et sellest vedela ksenooniga täidetud mahutist saab areen, kus tumeaine osake end esmakordselt ilmutab.  [15:50] |
| [16:06]  The bait for detecting that dark matter particle will be the nucleus of a xenon atom. [16:11] | [16:06]  Tumeaine osakese söödaks on ksenooni aatomite tuumad.  [16:11] |
| [16:11]  When a dark matter particle hits, the nucleus will give off a flash of light… or release electrons.  [16:19] | [16:11]  Kui tumeaine osake peaks seda tabama, tekib valgussähvatus või eralduvad aatomi küljest elektronid.  [16:19] |
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| [16:23]  These interactions will be recorded by sen­sors on the bottom and top of the detector.  [16:28] | [16:23]  Mõlemal juhul jäädvustavad sündmuse anuma peal ja põhjas olevad detektorid.  [16:28] |
| [16:44]  Dark matter interactions of *any* kind are rare, but physicists hope they’ll see one very soon. [16:50] | [16:44]  Tumeaine osakeste puhul on igasugused interaktsioonid väga haruldased, kuid füüsikud loodavad varsti mõnda näha.  [16:50] |
| **CERN** | **CERN** |
| [17:04]  On the other side of the world, another group of physicists is working on *creating* their *own* dark matter particle.  [17:12] | [17:04]  Teisel pool maakera üritab teine füüsikute rühm tumeaine osakesi ise luua.  [17:12] |
| [17:15]  They’re doing it here, at CERN, the world’s largest research center for the study of particle physics, located outside Geneva, Switzerland.  [17:24] | [17:15]  See toimub siin, CERNis, maailma suurimas osakestefüüsika uurimiskeskuses, mis asub Šveitsis Genfi lähedal.  [17:24] |
| [17:35]  Here, thousands of scientists from many nations have joined together to track down answers to humankind’s most complex, and age-old questions, concerning the nature of matter.  [17:46] | [17:35]  Siin on tuhanded teadlased paljudest riikidest ühendanud jõud, et vastata kõige keerulisematele ja vanematele küsimustele aine olemuse kohta.  [17:46] |
| [17:57]  Hidden beneath CERN’s sprawling 450 acre / 2 square kilometer campus and the surrounding forests and farms of the European countryside, lies the biggest and most complex machine in the world: the Large Hadron Collider, otherwise known as the “LHC.”  [18:17] | [17:57]  CERNi kahe ruutkilomeetri suuruse linnaku ning ümbritsevate metsade ja põldude all asub maailma kõige keerukam seadeldis – Suur Hadronite Põrguti.  [18:17] |
| [18:18]  Inside it, two beams of protons travel in opposite directions around the ring at incredible speeds.  [18:25] | [18:18]  Kiirendi sees kihutavad kaks prootonite kimpu tohutu kiirusega teineteisele vastu.  [18:25] |
| [18:28]  The protons then collide inside four gigantic detectors located on the LHC track.  [18:35] | [18:28]  Seejärel põrkuvad prootonid kokku ühes neljast suurest detektorist, mis kiirendi ringil asuvad.  [18:35] |
| [18:48]  The LHC is a giant particle racetrack. Instead of fuel, these subatomic racers are accele­ra­ted around the track by electric fields, and steered by high-powered magnets.  [19:04] | [18:48]  Suur Hardonite Põrguti on justkui algosakeste rallirada, kus kütuse asemel on tugev elektriväli ja osakeste tüürimiseks kasutatakse võimsaid magneteid.  [19:04] |
| [19:06]  The particles are then guidedtoward collision, in the core of each detector. [19:11] | [19:06]  Kui piisav kiirus on saavutatud, juhitakse osake­sed otse detektorite sisse üksteisega kokku põrkama.  [19:11] |
| [19:13]  The largest detector is appropriately called ATLAS. It weighs 7000 tons and took 15 long years to build.  [19:24] | [19:13]  Kõige suuremal detektoril on sobiv nimi – ATLAS. See kaalub 7000 tonni ning selle ehitamiseks kulus tervelt 15 aastat.  [19:24] |
| [19:25 – 20:05] ATLAS / Transformers Scene | [19:25 – 20:05] ATLAS / Detektori skeem |
| [20:06]  At almost 8-stories tall, ATLAS is the size of a cathedral.  [20:11] | [20:06]  ATLAS on ligi 8-korruselise maja kõrgune ning mahutaks enda sisse terve katedraali.  [20:11] |
| [20:13]  More than three thousand scientists from 175 institutions in 38 countries work in collaboration on its experiments.  [20:23] | [20:13]  Selle detektoriga on seotud üle 3000 teadlase 175 teadusasutusest ning 38 erinevast riigist.  [20:23] |
| [20:26]  In essence, ATLAS is an enormous micro­scope aimed down into the subatomic realm.  [20:32] | [20:26]  ATLAS on justkui hiiglaslik mikroskoop, mis uurib kõige väiksemaid algosakesi.  [20:32] |
| [20:34]  With billions of protons traveling around the track in opposite directions, the scene can seem more like a demolition derby than a racetrack.  [20:44] | [20:34]  Detektori sees kihutavad vastassuunas korraga miljardid prootonid – see vaatepilt meenutab rohkem romurallit kui võidusõitu.  [20:44] |
| [20:46]  When two protons collide, hundreds of new particles are formed.  [20:50] | [20:46]  Kahe prootoni kokkupõrkel tekib sadu uusi osakesi.  [20:50] |
| [20:52]  The incredible energy of the collision can produce particles with far greater mass than that of the two protons that created them. [21:00] | [20:52]  Kokkupõrkel eralduv energia on sedavõrd suur, et tekkida võivad algsetest prootonitest palju suurema massiga osakesed  [21:00] |
| [21:01]  This is exactly what physicists predict will happen if they create a dark matter particle with great mass.  [21:09] | [21:01]  See on just see, mida füüsikud ootavad: tekkida võib suure massiga tumeaine osake.  [21:09] |
| [21:10]  Every line in this collision display reflects the presence of a newly created particle.  [21:16] | [21:10]  Iga joon kokkupõrke pildil kujutab äsja tekkinud osakese jälge…  … ning joonte kõveruse järgi saame teada iga tekkinud osakese impulsi.  [21:20] |
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| [21:17]  The curvature of the line tells us the particle’s momentum.  [21:20] |
|  |  |
| [21:24]  ATLAS records the collisions with several de­vices that are arranged in concentric layers.  [21:29] | [21:24]  ATLAS salvestab iga kokkupõrke tulemused silindriliste kihtidena paiknevate detektoritega.  [21:29] |
| [21:32]  Each device is like an extraordinary camera, specially designed to detect and record different kinds of particles.  [21:39] | [21:32]  Iga detektor on justkui spetsiaalne kaamera, mis registreerib kindlat tüüpi osakesi.  [21:39] |
| [21:43]  According to Sir Isaac Newton, momentum traveling in opposite directions must balance out, as it does in this display. The yellow squares show an even distribution of particles and momentum.  [21:57] | [21:43]  Vastavalt Newtoni seadustele peab vastas­suunas lennanud osakeste koguimpulss olema tasakaalus. Seda näemegi pildil: kollased ruudud näitavad osakeste impulsside ühtlast jaotumist.  [21:57] |
| [21:59]  In the case of a dark matter particle, however, there will be a *gap* where the particle flew through ATLAS without interacting with *any* of its sub-detectors.  [22:09] | [21:59]  Kui aga peaks tekkima tumeaine osake, siis lendab see kõigist detektoritest ilma ühtegi jälge jätmata läbi ning tekib tühimik, kus ühtegi osakest ei tuvastatud.  [22:09] |
| [22:10]  How can a dark matter particle fly through the world’s most sensitive particle detector without leaving a trace?  [22:16] | [22:10]  Kuidas on võimalik, et tumeaine osake suudab läbida maailma kõige tundlikuma osakeste detektori vähimatki jälge jätmata?  [22:16] |
| SUSY | SUSY |
| [22:18]  A theory called Super-Symmetry predicts the existence of a particle that would act in exactly this manner.  [22:25] | [22:18]  Supersümmeetriaks nimetatud füüsikateooria ennustab just sel viisil käituvate osakeste olemasolu.  [22:25] |
| [22:27]  According to this theory, for every known particle, like an electron or quark, there’s a corresponding super particle with a much greater mass.  [22:37] | [22:27]  Selle teooria kohaselt on igal tuntud osakesel, näiteks elektronil või kvargil, supersümmeetriline kaaslane, millel on palju suurem mass.  [22:37] |
| [22:44]  As you can see, the correspondence creates a nice symmetry.  [22:48] | [22:44]  Selline osakeste vastavus tekitab kena sümmeetria.  [22:48] |
| [22:49]  Physicists believe that one of these predicted super particles may be the dark matter particle.  [22:55] | [22:49]  Füüsikud usuvad, et mõni neist super­sümmeetrilistest kaaslastest võibki olla otsitav tumeaine osake.  [22:55] |
| [22:56]  Now to find it…  [22:57] | [22:56]  Nüüd tuleb see vaid üles leida.  [22:57] |
| [23:02]  ATLAS takes pictures of the most important collision events 40 million times per second. [23:07] | [23:02]  ATLAS tuvastab prootonite kokkupõrkeid ligi 40 miljonit korda sekundis.  [23:07] |
| [23:19]  Collision data is stored in a massive network of computers at CERN and around the world called “The Grid.”  [23:26] | [23:19]  Kokkupõrgete andmeid hoiustatakse hiiglaslikus arvutivõrgus, mille osad asuvad nii CERNis kui ka mujal maailmas  [23:26] |
| [23:27]  Computer programs scan data in the Grid looking for patterns that might fit the profile of a dark matter particle.  [23:34] | [23:27]  Andmetöötlusega tegelevad arvuti­program­mid otsivad kokkupõrgete seast osakeste jälgi, mis võiks viidata tumeaine tekkele.  [23:34] |
| [23:35]  Very few collisions are expected to create dark matter particles, but if one did, looking through all the collision data would be a daunting task.  [23:43] | [23:35]  Arvatavasti tekib see osake vaid väga harvadel juhtudel, kuid kui see juhtuma peaks, siis selle tohutust andmehulgast üles leidmine ei ole sugugi kerge töö.  [23:43] |
| [23:47]  Fortunately, modern science is a collaborative endeavor. Physicists all over the planet are working around the clock to analyze the data.  [23:56] | [23:47]  Õnneks on tänapäevase teaduse aluseks koostöö. Andmete analüüsimisega tegelevad füüsikud ja arvutiprogrammid vahetpidamata üle terve maailma.  [23:56] |
| [23:58]  A CERN engineer invented a thing called the “World Wide Web” in order to share this kind of information.  [24:04] | [23:58]  CERNi andmete ja info vahetamiseks loodi omal ajal ülemaailmne arvutivõrk, mida tänapäeval tunneme Interneti nime all.  [24:04] |
| [24:06]  With all this brainpower looking for dark matter and exploring the fundamental nature of our universe, who knows what they may find?  [24:14] | [24:06]  Arvestades, kui palju helgeid päid ja arvutusvõimsust on tänaseks tumeaine otsingutele ja algosakeste uurimisele pühendatud, siis näitab vaid aeg, mida avastada suudetakse.  [24:14] |
| [24:16]  Ultimately, it’s the big questions that bring humankind closer together as we strive to understand the workings of this vast universe and our place in it.  [24:27] | [24:16]  Kokkuvõtteks ongi selliste suurte küsimuste küsimine Universumi ja meie rolli kohta selles vajalik, sundimaks inimkonda oma jõudusid ühendama, et neile küsimustele üheskoos vastata.  [24:27] |
| [24:33] END OF FADE TO BLACK | [24:33] LÕPP |
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