Covering current developments in high-energy physics and related fields worldwide

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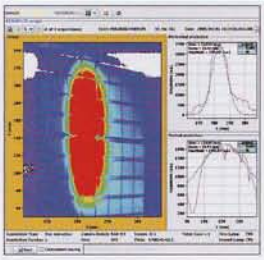

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Cover: In March 1989 Tim Berners-Lee, a physicist at CERN, handed a document to his supervisor Mike Sendall, titled "Information Management: a Proposal". "Vague, but exciting", were the words that Sendall wrote on the proposal, allowing Berners-Lee to continue with the project. This low-key beginning to the phenomenon that became the World Wide Web was celebrated at CERN in March (p24).

New Zealand meeting looks at dark matter

Participants from around the world gathered in Christchurch, New Zealand, for the Dark 2009 conference in January. **Hans Volker Klapdor-Kleingrothaus** reports.

The 7th Heidelberg International Conference on Dark Matter in Astrophysics and Particle Physics – Dark 2009 – was held at Canterbury University in Christchurch on 18–24 January. The event saw 56 invited talks and contributions, which provided an exciting and up-to-date view of the development of research in the field. The participants represented well the distribution of dark-matter activities around the world: 25 from Europe, 11 from the US, 5 from Japan and Korea, 14 from Australia and New Zealand, and 1 from Iran. The programme covered the traditionally wide range of topics, so this report looks at the main highlights.

The conference started with an overview of searches for supersymmetry at the LHC and dark matter by Elisabetta Barberio of the University of Melbourne. To date, the only evidence for cold dark matter from underground detectors is from the DAMA/LIBRA experiment in the Gran Sasso National Laboratory, as Pierluigi Belli from the collaboration explained. This experiment, which looks for an expected seasonal modulation of the signal for weakly interacting massive particles (WIMPs), now has a significance of 8.4 σ. Unfortunately, all other direct searches for dark matter do not currently have the statistics to look for this signal. Nevertheless, Jason Kumar from Hawaii described how testing the DAMA/LIBRA result at the Super-Kamiokande detector might prove interesting.

Later sessions covered other searches for dark matter. Tarek Saab from Florida gave an overview of ongoing direct searches in underground laboratories, including recent results from the Cryogenic Dark Matter Search experiment in the Soudan mine, and Nigel Smith of the UK's Rutherford Appleton Laboratory presented results from the ZEPLIN III experiment in the Boulby mine. Irina Krivosheina of Heidelberg and Nishnij Novgorod discussed the potential offered by using bare germanium detectors in liquid nitrogen or argon for dark-matter searches, on the basis of the results from the GENIUS-Test-Facility in the Gran Sasso National Laboratory. Chung-Lin Shan of Seoul National University reported on how precisely WIMPs can be identified in experimental searches in a model-independent way.

Searching for signals from dark-matter annihilation in X-rays and weighing supermassive black holes with X-ray emitting gas were subjects for Tesla Jeltema of the University of California Observatories/Lick Observatory and David Buote of the University of California, Irvine. Stefano Profumo of the University of California, Santa Cruz, provided an overview of fundamental physics with giga-electron- volt gamma rays. Iris Gebauer of Karlsruhe addressed the excess of cosmic positrons indicated by the Energetic Gamma Ray Experiment Telescope, which are still under discussion, as well as the new anomalies observed by the Payload for Antimatter Matter Exploration and Light-Nuclei Astrophysics (PAMELA, p12) satellite experiment and the Advanced Thin Ionization Calorimeter (ATIC) balloon experiment. These results and the limits that they set on some annihilating dark matter (neutralino or gravitino) models were also discussed by Kazunori Nakayama of Tokyo and Koji Ishiwata of Tohoku.

Participants of DARK 2009 at the monument for Robert Falcon Scott, who started his Antarctic expedition from Christchurch in 1910.

Other presentations outlined results and prospects for the AMANDA, IceCube and ANTARES experiments, which study cosmic neutrinos – though there is still a long way to go before they have conclusive results. Emmanuel Moulin of the Commissariat à l'Énergie Atomique/Saclay presented results from imaging atmospheric Cherenkov telescopes, in particular the recent measurements from HESS, which exploited the fact that dwarf spheroidal ▷

galaxies, such as Canis Major, are highly enriched in dark matter and are therefore good candidates for its detection. Unfortunately, the results do not yet have the sensitivity of the Wilkinson Microwave Anisotropy Probe in restricting either the minimal supersymmetric Standard Model or Kaluza–Klein scenarios.

Leszek Roszkowski of Sheffield gave an overview of supersymmetric particles (neutralinos) as cold dark matter, while scenarios of gravitino dark matter and their cosmological and particle-physics implications were presented by Gilbert Moultaka of the University of Montpellier and Yudi Santoso of the Institute for Particle Physics Phenomenology, Durham. Dharam Vir Ahluwalia of the University of Canterbury put the case for the existence of a local fermionic dark-matter candidate with mass-dimension one, on the basis of non-standard Wigner classes. However, as the proposed fields, as outlined in detail by Ben Martin of Canterbury, do not fit into Steven Weinberg's formalism of quantum-field theory, this suggestion led to dispute between other experts. An interesting candidate for dark matter was presented by Norma Susanna Mankoc-Borstnik of the University of Ljubljana, who proposed a fifth family as candidates for forming dark matter.

Dark energy and the cosmos

Dark energy was a major topic at the conference. Chris Blake of Swinburn University of Technology in Melbourne presented the prospects for the WiggleZ survey at the Anglo-Australian Telescope, the most sensitive experiment of this kind, and Matt Visser of Victoria University in Wellington gave a cosmographic analysis of dark energy. On the theoretical side there are diverging approaches to dark energy, including attempts to explain it in a "radically conservative way without dark energy", as David Wiltshire of Canterbury University, Christchurch, explained.

A particular highlight was the presentation by Terry Goldman of Los Alamos, which discussed a possible connection between sterile fermion mass and dark energy. His conclusion was that a neutrino with mass of 0.3 eV could solve the problem of dark energy. This possibility was qualitatively supported by results of non-extensive statistics in astroparticle physics that Manfred Leubner of the University of Innsbruck presented, in the sense that dark energy is expected to behave like an ordinary gas. Goldman's suggestion is also of interest with respect to the final result of the Heidelberg–Moscow double-beta-decay experiment, reported by Hans Klapdor-Kleingrothaus, which predicts a Majorana neutrino mass of 0.2–0.3 eV.

Danny Marfatia of the University of Kansas discussed mass-varying neutrinos in his presentation about phase transition in the fine structure constant. He proposed that the coupling of neutrinos to a light scalar field might explain why $\Omega_{\text{dark energy}}$ is of the same order as Ω_{matter}. Possible connections between dark matter and dark energy with models of warped extra dimensions and the hierarchy problem were outlined by Ishwaree Neupane of the University of Canterbury and Yong Min Cho of Seoul National University.

Dark mass and the centre of the galaxy was the topic of a special session in which Andreas Eckart of the University of Cologne presented recent results on the luminous accretion onto the dark mass at the centre of the Milky Way. Patrick Scott of Stockholm University discussed dark stars at the galactic centre, while Benoit Famaey of the Université Libre de Bruxelles and Felix Stoehr of the Space Telescope European Coordinating Facility/ESO in Garching discussed the distribution of dark and baryonic matter in galaxies. Primordial molecules and the first structures in the universe were the topics addressed by Denis Puy of the Univesité Montpellier II. Youssef Sobouti of the Institute of Advanced Studies on Basic Science in Zanjan, Iran, presented a theorem on a "natural" connection between baryonic dark matter and its dark companion, while Matthias Buckley of the California Institute of Technology put forward ideas about dark matter and "dark radiation".

Gravity also came under scrutiny. David Rapetti of SLAC explored the potential of constraining gravity with the growth of structure in X-ray galaxy clusters, while Agnieszka Jacholkowska of IN2P3/Centre National de la Recherche Scientifique gave an experimental view of probing quantum-gravity effects with astrophysical sources. In a special session on general relativity, Roy Patrick Kerr of Canterbury University gave an interesting historical lecture entitled "Cracking the Einstein Code".

To conclude, the lively and highly stimulating atmosphere of Dark 2009 reflected a splendid future for research in the field of dark matter in the universe and for particle physics beyond the Standard Model. The proceedings will be published by World Scientific.

Further reading

For the presentations at Dark 2009, see www.klapdor-k.de/Conferences/Program09.htm.

Résumé

La Nouvelle-Zélande se penche sur la matière noire

Des spécialistes du monde entier se sont réunis en janvier 2009 à Christchurch (Nouvelle-Zélande) pour la 7e Conférence internationale d'astrophysique et de physique des particules sur la matière noire. Quelque 56 communications et contributions passionnantes ont permis de faire un tour d'horizon des derniers développements de la recherche dans le domaine de la matière noire. Cette conférence, généralement biennale, rassemble des chercheurs travaillant dans les domaines de la cosmologie, l'astrophysique, la physique des particules et la physique nucléaire. Cette année, les thèmes comprenaient la recherche (directe ou indirecte) de la matière noire, divers aspects de l'énergie sombre, la structure à grande échelle et la gravité quantique.

Hans Volker Klapdor-Kleingrothaus, *Heidelberg.*