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ASACUSA sees surprising behaviour of hybrid matter–antimatter atoms in superfluid helium

The result may open doors to several lines of research in particle physics and beyond

Masaki Hori, ASACUSA co-spokesperson (Image: CERN)

A hybrid matter–antimatter helium atom containing an antiproton, the proton's antimatter equivalent, in place of an electron has an unexpected response to laser light when immersed in superfluid helium, reports the ASACUSA collaboration at CERN. The result, described in a paper published today in the journal Nature, may open doors to several lines of research. "Our study suggests that hybrid matter–antimatter helium atoms could be used beyond particle physics, in particular in condensed-matter physics and perhaps even in astrophysics experiments," says ASACUSA co-spokesperson Masaki Hori. "We have arguably made the first step in using antiprotons to study condensed matter." The ASACUSA collaboration is well used to making hybrid matter–antimatter helium atoms to determine the antiproton's mass and compare it with that of the proton. These hybrid atoms contain an antiproton and an electron around the helium nucleus (instead of two electrons around a helium nucleus) and are made by m ...

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A word from Benoît Delille

Two years of COVID-19 measures at CERN: Thank you for your commitment and your resilience

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In this issue / Dans ce numéro

Two years of COVID-19 measures at CERN: Thank you for your commitment and your resilience

With the move to COVID-19 Level 1 – Green on Monday, 14 March, I feel hopeful that the worst of the pandemic is behind us, even though we all need to remain vigilant, safe and responsible. On behalf of the CERN Management, this is a “thank you” to the CERN community at large, for your commitment and resilience during these unprecedented times.

The unique geographical situation of CERN, straddling two Host States, and the diversity of its workforce and stakeholders made the design of suitable COVID-19 measures a particular challenge. We met this challenge by displaying a spirit of inclusiveness that accommodated different opinions and by staying as science-based as possible. A comprehensive set of measures, including effective testing and contact-tracing programmes, enabled us to limit on-site transmission and keep the Laboratory open and safe to pursue its mission.

Innovation, commitment and creativity shone through many COVID-related initiatives. At the beginning of the pandemic, CERN reached out to its neighbours by creating a dedicated COVID-19 taskforce (https://home.cern/news/news/cern/initiatives-cern-community-global-fight-against-covid-19) and reinforcing the local emergency response (https://home.cern/news/news/cern/cerns-fire-and-rescue-service-supports-swiss-and-french-ambulance-drivers) with the support of the CERN Fire and Rescue Service. The CARA (https://home.cern/news/news/cern/introducing-cara-cerns-covid-airborne-risk-assessment-tool) (COVID Airborne Risk Assessment) tool, which was developed to model the concentration of viruses in enclosed spaces to help with space management during the pandemic, has since been adopted beyond CERN’s confines and will help in the longer term to ensure good air quality in workspaces. In addition, an on-site vaccination centre (https://home.cern/news/news/cern/cern-hosts-covid-19-vaccination-centre) catered for colleagues and their family members living in both France and Switzerland. These are just a few examples of the collective efforts made.

Throughout, all the CERN teams worked side by side. Dedicated health and safety measures, HR support and COVID helplines were coordinated and brought together on our dedicated HSE webpages (https://hse.cern/covid-19-information) to keep you informed at all stages of the pandemic. The implementation of the four-level COVID-19 scale (https://home.cern/news/news/cern/cerns-covid-scale-and-measures) last June was yet another joint effort that enabled a swift adjustment of the many impacted services at all stages of the pandemic.

The situation is being continuously monitored as the coronavirus is still circulating and is set to become part of our lives. With fewer measures in Level 1 – Green, we will all have to learn how to live and work safely with the virus, in a spirit of respect and tolerance, all the while breathing life back into our unique campus-like environment: a place where we can favour face-to-face exchanges to fuel our innovative minds, while ensuring due protection for those who are vulnerable and at higher risk.

For my part, having taken the helm of the HSE unit at the start of 2021, I look forward to continuing to work closely with all our partners who have helped us to successfully meet the challenges of the pandemic and, more generally, with the CERN community on a range of other subjects within the wider mission of the HSE unit. Together, we will strive to support research and innovation by building sustainable and healthy foundations.

Benoît Delille

ASACUSA sees surprising behaviour of hybrid matter–antimatter atoms in superfluid helium

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A hybrid matter–antimatter helium atom containing an antiproton, the proton’s antimatter equivalent, in place of an electron has an unexpected response to laser light when immersed in superfluid helium, reports the ASACUSA collaboration at CERN. The result, described in a paper published today in the journal *Nature* (https://www.nature.com/articles/s41586-022-04440-7) , may open doors to several lines of research.

“Our study suggests that hybrid matter–antimatter helium atoms could be used beyond particle physics, in particular in condensed-matter physics and perhaps even in astrophysics experiments,” says ASACUSA co-spokesperson Masaki Hori. “We have arguably made the first step in using antiprotons to study condensed matter.”

The ASACUSA collaboration is well used to making hybrid matter–antimatter helium atoms to determine the antiproton’s mass and compare it with that of the proton. These hybrid atoms contain an antiproton and an electron around the helium nucleus (instead of two electrons around a helium nucleus) and are made by mixing antiprotons produced at CERN’s antimatter factory with a helium gas that has a low atomic density and is kept at low temperature.

Low gas densities and temperatures have played a key role in these antimatter studies, which involve measuring the response of the hybrid atoms to laser light in order to determine their light spectrum. High gas densities and temperatures result in spectral lines, caused by transitions of the antiproton or electron between energy levels, that are too broad, or even obscured, to allow the mass of the antiproton relative to that of the electron to be determined.

This is why it came as surprise to the ASACUSA researchers that, when they used liquid helium, which has a much higher density than gaseous helium, in their new study, they saw a decrease in the width of the antiproton spectral lines.

Moreover, when they decreased the temperature of the liquid helium to values below the temperature at which the liquid becomes a superfluid, i.e. flows without any resistance, they found an abrupt further narrowing of the spectral lines.

“This behaviour was unexpected,” says Anna Sótér, who was the principal PhD student working on the experiment and is now an assistant professor at ETHZ. “The optical response of the hybrid helium atom in superfluid helium is starkly different to that of

the same hybrid atom in high-density gaseous helium, as well as that of many normal atoms in liquids or superfluids."

The researchers think that the surprising behaviour observed is linked to the radius of the electronic orbital, i.e. the distance at which the hybrid helium atom's electron is located. In contrast to that of many normal atoms, the radius of the hybrid atom's electronic orbital changes very little when laser light is shone on the atom and thus does not affect the spectral lines even when the atom is immersed in superfluid helium. However, further studies are needed to confirm this hypothesis.

The result has several ramifications. Firstly, researchers may create other hybrid helium atoms, such as pionic helium atoms, in superfluid helium using different antimatter and exotic particles, to study their response to laser light in detail and measure the particle masses. Secondly, the substantial narrowing of the lines in superfluid helium suggests that hybrid helium atoms could be used to study this form of matter and potentially other condensed-matter phases. Finally, the narrow spectral lines could in principle be used to search for cosmic antiprotons or antideuterons (a nucleus made of an antiproton and an antineutron) of particularly low velocity that hit the liquid or superfluid helium that is used to cool experiments in space or in high-altitude balloons. However, numerous technical challenges must be overcome before the method becomes complementary to existing techniques for searching for these forms of antimatter.

Photos

https://cds.cern.ch/record/2801207/files/202202-025_50.jpg?subformat=icon-1440 (https://cds.cern.ch/record/2801207/files/202202-025_50.jpg?subformat=icon-1440)

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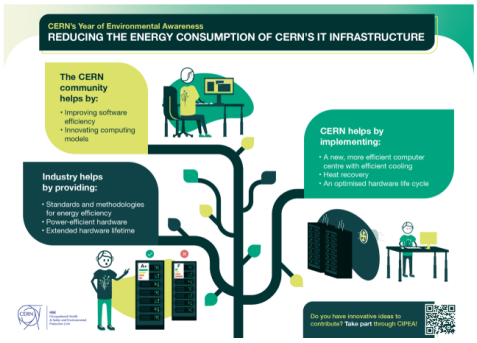
Videos

https://videos.cern.ch/record/2295468 (https://videos.cern.ch/record/2295468)

https://videos.cern.ch/record/2295467 (https://videos.cern.ch/record/2295467)

Environmental awareness: reducing the energy consumption of CERN's IT infrastructure



(Image: CERN)

Energy consumption related to data processing is one of the main environmental impacts of CERN's IT infrastructure and activities. Around 75% of the energy used in data centre activities at CERN is for data processing, while the remaining 25% is dedicated to data storage.

As shown in this infographic, three main actors could contribute to reducing energy consumption in data processing, thereby reducing CERN's environmental impact: industry, CERN as an organisation, and the CERN community.

Read more on how CERN is working to reduce the environmental impact of its IT infrastructure here (https://home.cern/news/news/cern/environmental-awareness-challenges-cerns-it-infrastructure) .

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This infographic is part of the series "CERN's Year of Environmental Awareness".

Writing up the results: award-winning writers visit CERN

Stories inspired by the visit will be published in an anthology later this year

The delegation visited the CERN sites on 11 March 2022 (Image: CERN)

On Friday, 11 March, a delegation of internationally acclaimed fiction writers visited CERN as part of an undertaking pairing authors with CERN scientists to explore the science and theory behind CERN's work through fiction. The writers included science-fiction author Ian Watson (whose credits include the screen story for the film *A.I.*), BBC National Short Story Award winner Lucy Caldwell, and novelist and screenwriter Courttia Newland (who recently worked with Steve McQueen on the award-winning *Small Axe* series). During their stay, the writers visited CMS, the Antiproton Decelerator, the Data Centre and the Synchrocyclotron.

The project is supported by UK Research and Innovation (UKRI) and the Science and Technology Facilities Council (STFC) as part of HL-LHC-UK phase 2 and has been devised as an alternative to the usual process of reflecting on, and disseminating, new research ideas. Writers and scientists work together to exchange ideas, with the latter acting as consultants to make sure the science is accurately represented. The scientists also write short afterwords to accompany the finished fictions, explaining and contextualising the story's science in an accessible way to the general reader. The project is part of the wider "science-into-fiction" series initiated by Comma Press, a British publishing house, which has produced seven books to date. The project is coordinated by the University of Manchester and Cockcroft Institute, and CERN. The stories inspired by this visit and the various surrounding consultations will be published later this year in an anthology and will be launched at various festivals in the United Kingdom later in the year.

Thirty years of Hungarian membership of CERN: the President of the Republic visits the Organization

President Áder visited the CMS cavern and the Globe of Science and Innovation to mark the anniversary of his country joining CERN

President János Áder with CERN Director-General Fabiola Gianotti at the Globe of Science and Innovation (Image: CERN)

Like many central and eastern European countries, Hungary became a CERN Member State following the fall of the Iron Curtain. The country's president, János Áder, came to CERN on 8 March 2022 on an official visit to see for himself the fruits of thirty years of shared history. Accompanied by his wife, Anita Herczegh, and his delegation, the President met the Director-General, Fabiola Gianotti, and several CERN Directors, as well as the spokesperson of the CMS collaboration, Luca Malgeri, at Point 5 of the Large Hadron Collider (LHC).

Following preliminary discussions, the President visited the CMS experiment cavern and learned all about the research being carried out at CERN. His delegation then visited the Globe of Science and Innovation, where he participated in a roundtable discussion with Hungarian scientists. Following an exchange of gifts, the President rounded off his visit with a stop at the Science Gateway site, where work continues in front of the Globe.

Since Hungary became a CERN Member State in 1992, its relationship with the Laboratory has gone from strength to strength, with many Hungarian scientists involved in the ALICE and CMS experiments at the LHC, as well as in research programmes on antimatter and the development of new accelerator technologies. The country also hosts, at the Wigner Research Centre for Physics in Budapest, a major Worldwide LHC Computing Grid centre, where data collected by the collider is processed.

Thomas Hortala

ATLAS celebrates its 2021 Thesis Award winners

Six young researchers were honoured in an online ceremony on 24 February

2021 ATLAS Thesis Award winners pose with their theses. From left to right, top row: Giulia Di Gregorio, Jackson Carl Burzynski and Stefan Popa. Bottom row: Alexander Leopold, Manuel Guth and Zachary Michael Schillaci. (Image: CERN)

Every year, the ATLAS collaboration comes together to celebrate the work of its PhD students through the ATLAS Thesis Awards. The winners of the 2021 edition were announced in an online ceremony on 24 February. The recipients are Jackson Carl Burzynski (https://cds.cern.ch/record/2780737/) (Simon Fraser University), Giulia Di Gregorio (https://cds.cern.ch/record/2759132?ln=en) (University & INFN Pisa), Manuel Guth (https://cds.cern.ch/record/2765038?ln=en) (University of Geneva), Alexander Leopold (https://cds.cern.ch/record/2765448?ln=en) (KTH Royal Institute of Technology), Stefan Popa (https://cds.cern.ch/record/2783425?ln=en) (Transilvania University of Braşov) and Zachary Michael Schillaci (https://cds.cern.ch/record/2781193?ln=en) (Brandeis University).

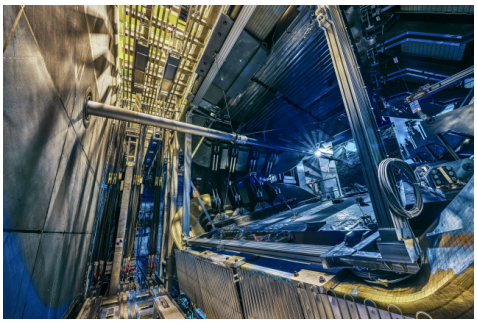
Thesis Awards Chair Tomasz Bold praised the high quality of the 36 nominations, noting that the winners were selected "out of many outstanding physics results and valuable service work to the collaboration". These awards, he added, "are a unique opportunity to shed light on the essential work carried out by students".

The winners each gave a presentation on their time spent as ATLAS students, sharing their experiences and summarising their research. Their talks reflected the diversity of ATLAS research, including searches for exotic new particles, novel detector design for the HL-LHC upgrade of ATLAS and precision measurements of the Standard Model. They also acknowledged the mentors, family members and peers who had supported them throughout their PhD.

Find out more on the ATLAS website (https://atlas.cern/updates/news/2021-thesis-awards) .

Largest matter-antimatter asymmetry observed

New results from the LHCb experiment on CP asymmetry in charmless three-body charged B meson decays include the largest CP asymmetry ever observed



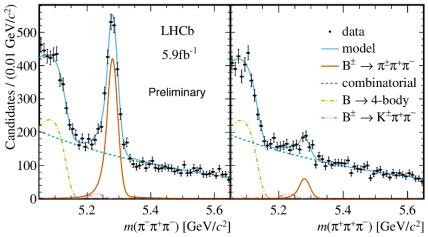
The LHCb detector in 2018, opened up for extensive upgrades during LHC Long Shutdown 2. (Image: CERN)

CP asymmetry is the only non-trivial difference between matter and antimatter found so far. Its discovery in neutral kaon decays in 1964 came as a big surprise to the physics community, but today it is an essential component of the Standard Model of particle physics. Without CP asymmetry the Big Bang would have created equal amounts of matter and antimatter, which would all have then annihilated, leaving behind an empty Universe filled with radiation. To produce a matter-dominated Universe like the one we live in, an excess of matter must have formed and survived this annihilation. But to produce such an excess, some difference between matter and antimatter must be present: enter CP asymmetry. Unfortunately, the amount of CP asymmetry present in the Standard Model of particle physics is not enough to explain the observed composition of the Universe, driving extensive studies of this phenomenon and searches for other sources of CP asymmetry.

This week, at the *Rencontres de Moriond Electroweak* conference and during a seminar held at CERN (https://indico.cern.ch/event/1137298/) , the LHCb collaboration presented new results from studies of CP asymmetry in charmless three-body decays of charged B mesons. These decays involve a charged B meson, consisting of a beauty quark and an up quark, transforming into a combination of π and K mesons. The name “charmless” refers to the absence of charm quarks in the final state: $\pi^{\pm}$ mesons (pions) contain only up and down quarks, and $K^{\pm}$ mesons (kaons) contain a strange and an up quark. Charmless decays involve the transformation of a beauty quark into an up quark, which is an unlikely process, as the beauty quark predominantly decays into a charm quark. In this rare process the effects of CP violation are expected to be enhanced.

The new LHCb results focus on “direct” CP violation: a phenomenon where the same decay process has a different probability for a particle than for an antiparticle. The strongest global asymmetry was observed for the decay into two kaons and one pion, where the probability of a $B^+ \to \pi^+K^+K^-$ decay is about 20% higher than for the $B^- \to \pi^-K^+K^-$decay (corresponding to a measured CP asymmetry A_{CP} of -0.114). A global CP asymmetry has also been observed with a significance of more than five standard deviations for the first time in decays into three pions and decays into three kaons. For the final state with two pions and one kaon, CP violation is still not confirmed.

The three-particle final state can, however, be studied further in order to extract more information. The process of a B meson transforming into three particles can occur in several steps, with intermediate short-lived particles (“resonances”) forming and subsequently decaying into the pions and kaons seen in the final state. These processes can make different contributions to the CP asymmetry and can be disentangled by taking into account the momenta of the final state particles in what’s known as “phase space analysis”. One spectacular result of such an analysis is the indication of a χ_{hc}^0 meson (containing a charm-anticharm quark pair) being formed during the $B \to \pi\pi\pi$ decay. The χ_{hc}^0 was not expected to contribute to CP violation but the results show the presence of a significant asymmetry. In fact, the subset of data containing the χ_{hc}^0 events features the highest CP asymmetry ever observed: the B^- meson makes an almost 7 times greater contribution to this process than its B^+counterpart, as can be seen in the plot below.



(https://cds.cern.ch/images/CERN-HOMEWEB-PHO-2022-036-1)

Invariant mass of the three pion final state in a pre-defined phase space region. A clear signal from the B- (left plot) and B+ candidates (right plot) is visible as a peak at 5.28 GeV/c2. The difference between the height of these two peaks corresponds to the CP asymmetry in the region under study. (Image: CERN)

The results presented provide important clues about the mechanism of CP asymmetry generation in the Standard Model, which is not yet fully understood. Even more detailed studies will be performed in the upcoming LHC Run 3 with the newly-upgraded LHCb detector.

Read more on the LHCb website (https://lhcb-outreach.web.cern.ch/) .

Piotr Traczyk

Computer Security: PhishMS

Clicking on the wrong malicious link or attachment, or disclosing your password in reply to a malicious email or on a fake and nasty CERN single sign-on page, are two major attack vectors for the evil side to infiltrate CERN

Clicking on the wrong malicious link or attachment, or disclosing your password in reply to a malicious email or on a fake and nasty CERN single sign-on page, are two major attack vectors for the evil side to infiltrate CERN. That’s why the Computer Security team is testing (https://cds.cern.ch/journal/CERNBulletin/2016/09/News%20Articles/2133799?ln=en) you again (https://home.cern/news/news/computing/computer-security-one-click-and-boom-reloaded) and again (https://home.cern/news/news/computing/computer-security-free-click-your-awareness) with its clicking campaigns (see here (https://home.cern/news/news/computing/computer-security-click-me-not) , here (https://home.cern/news/news/computing/computer-security-cern-has-been-phished-again) and here (https://home.cern/news/news/computing/computer-security-truth-lies-url)). While those were focusing on malicious messages received by email, we should not ignore other vectors, like SMSs.

SMSs, iMessages and (with greater difficulty) chat messages via apps like WhatsApp, Signal or Threema can also be used to distribute unsolicited messages containing malicious content that try to lure you into clicking on an embedded link that misdirects you to a fake login page or downloading infected software directly to your device:

(https://cds.cern.ch/images/CERN-HOMEWEB-PHO-2022-043-1)

Clicking on that t.ly link could lead you anywhere, and it’s hard to figure out whether the destination is harmless or dangerous to your device and password – just like with

today's very popular QR codes ("'Check me' comes before 'Scan me' (https://home.cern/news/news/computing/computer-security-check-me-comes-scan-me) "). SMSs are a particularly interesting attack vector, as the relevant phone numbers can be enumerated, so attackers target a telephone range, like that of CERN's +41 75 411 nnnn. Protective counter measures are rarely effective, in particular if the emitting sender's phone number varies or is spoofed. So, while in messenger apps the attacker or idiot distributing malicious links must be part of your peers, group or friends, SMSs can arrive totally unsolicited.

In either case, beware! As we have tried to instil in you with our clicking campaigns, be vigilant and suspicious when receiving unsolicited messages via SMS, iMessage, WhatsApp and the like. Check the package: Does the message come from someone you know? Do its contents relate to who you are, what you do, what you expect? Or does it come as a surprise? If it's the latter, tame your curiosity. Refrain from clicking. Save your device and account from evil, and yourself from wasting time. Don't give PhishMSs a chance.

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Do you want to learn more about computer security incidents and issues at CERN? Follow our Monthly Report (https://cern.ch/security/reports/en/monthly_reports.shtml) . For further information, questions or help, check our website (https://cern.ch/Computer.Security) or contact us at Computer.Security@cern.ch.

Computer Security team

Official communications

Composition of the Joint Advisory Disciplinary Board (JADB / CPCD)

2022 Exercise

	Appointed by the Director-General	Appointed by the Staff Association
Members	John PYM / DG	Nick ZIOGAS / IPT
1st deputies	Gianluigi ARDUINI / BE	Kurt WEISS / BE
2nd deputies	Rosario PRINCIPE / TE	Gunnar LINDELL / HSE

John Pym and Nick Ziogas have drawn up the following list of staff members from among whom the Chairperson of the Board may be chosen when required:

- Sophie BARON / EP
- Ronny BILLEN / BE
- Johan BREMER / TE
- Alexandra HAHNEL-BORGEAUD / IPT
- Quentin KING / SY
- Kandy MITCHELL / PF
- Alberto PACE / IT
- Laurent TAVIAN / ATS
- Gabriele THIEDE / FAP
- Giovanna VANDONI / ATS

HR department

Composition of the Joint Advisory Appeals Board (JAAB / CPCR)

2022 exercise

Appointed by the Director-General: Dorothée DURET / FAP (member), Valeria PEREZ REALE / TE (1st deputy), Raymond VENESS / SY (2nd deputy).

Appointed by the Staff Association: François DUVAL / EP (member), Nicolas SALOMON / PF (1st deputy), Silvia SCHUH-ERHARD / BE (2nd deputy).

Dorothée Duret and François Duval have established the following list of the ten staff members from whom the Chairperson of the Commission will be chosen each time a case arises:

- Myriam AYASS / IPT
- François BRIARD / IR
- François BUTIN / BE
- Mark BUTTNER / BE
- Etienne CARLIER / SY
- Joël CLOSIER / EP
- Silvia GRAU / EN
- Arash KHODABANDEH / IT
- Pedro MARTEL / EN
- Jens VIGEN / RCS

Mediators [see Administrative Circular N° 6 (Rev. 1) entitled "Review procedure"] will also be selected from this list of ten staff members.

HR department

Ombud's corner

When respect is missing

It's rare that visitors to the Ombud's office complain about the outcome of administrative decisions. There are many types of decision that can impact someone's career, from not awarding a contract or a promotion to rejecting or imposing internal mobility, or a refusal to grant the requested resources. Such decisions are generally expected and mostly understood, even if they're not always welcome.

Whatever the consequences of the decision and whatever is at stake for the person concerned (family, career, etc.), what drives people to come and talk to me about the experience, which in many cases has hit them hard, is how the decision has been taken and communicated and the lack of respect shown towards them.

The respect that others show us, like esteem, is part of our dignity, so it's no wonder that we're so taken aback and upset when it's missing.

Showing a colleague respect, whatever the decision that's been taken, demonstrates that you see that colleague as a person and give credit to their intelligence. Everyone is entitled to respect, so it is important that you follow all the steps of the communication process:

- Prepare and lay the foundations for the decision, allowing time for as much discussion as needed;
- Explain – and explain again, if necessary – openly and honestly, the reasons for the decision, the process behind it and the criteria that have been taken into account;
- Provide evidence that a fair and transparent process has been followed;
- Show empathy and your ability to put yourself in the person's shoes and understand what they may be feeling;
- Help the person to bounce back by giving them all the support you can. This is only fair and recognises their contributions to and investment in the Laboratory;
- Once you've announced the decision, make it clear that the person can come and talk to you at any time to avoid them feeling isolated and disoriented.

We are always being reminded about the importance of respect but, just as when it comes to trust, leadership, listening, integrity and excellence, what really convinces and inspires us is seeing it in action, with words matched by deeds.

360-degree respect is not only respect between peers but respect between all levels of the hierarchical structure, both bottom-up and top-down, and respect in applying the processes that govern our professional lives.

A lack of respect can have a terrible impact on a colleague at any stage of their career. So let's get to grips with the problem and make sure that 360-degree respect becomes a reality and not just a worthy ambition.

You will find in the Learning Hub a very useful compilation of articles, videos and podcasts about respect in the workplace (https://lms.cern.ch/ekp/servlet/ekp?CID=EKP000043813&TX=FORMAT1&BACKTOCATALOG=Y&DECORATEPAGE=N) , have a look!

Laure Esteveny

I want to hear from you – feel free to send an e-mail to ombud@cern.ch with any feedback or suggestions for topics you'd like me to address.
NB: If you would like to be notified about posts, news and other communications from the CERN Ombud, please register to CERN Ombud news (https://e-groups.cern.ch/e-groups/EgroupsSubscription.do?egroupName=cern-ombud-news) .