= Copernicium =

Copernicium is a chemical element with symbol Cn and atomic number 112 . It is an extremely radioactive synthetic element that can only be created in a laboratory . The most stable known isotope , copernicium @-@ 285 , has a half @-@ life of approximately 29 seconds , but it is possible that this copernicium isotope may have a nuclear isomer with a longer half @-@ life , 8 @.@ 9 min . Copernicium was first created in 1996 by the GSI Helmholtz Centre for Heavy Ion Research near Darmstadt , Germany . It is named after the astronomer Nicolaus Copernicus .

In the periodic table of the elements , it is a d @-@ block transactinide element . During reactions with gold , it has been shown to be an extremely volatile metal and a group 12 element , and it may even be a gas at standard temperature and pressure . Copernicium is calculated to have several properties that differ between it and its lighter homologues , zinc , cadmium and mercury ; the most notable of them is withdrawing two 6d @-@ electrons before 7s ones due to relativistic effects , which confirm copernicium as an undisputed transition metal . Copernicium is also calculated to show a predominance of the oxidation state + 4 , while mercury shows it in only one compound at extreme conditions and zinc and cadmium do not show it at all . It has also been predicted to be more difficult to oxidise copernicium from its neutral state than the other group 12 elements .

In total , approximately 75 atoms of copernicium have been detected using various nuclear reactions .

= = History = =

= = = Official discovery = = =

Copernicium was first created on February 9 , 1996 , at the Gesellschaft für Schwerionenforschung (GSI) in Darmstadt , Germany , by Sigurd Hofmann , Victor Ninov et al . This element was created by firing accelerated zinc @-@ 70 nuclei at a target made of lead @-@ 208 nuclei in a heavy ion accelerator . A single atom (the second was subsequently dismissed) of copernicium was produced with a mass number of 277 .

208
82Pb + 70
30Zn ? 278
112Cn * ? 277
112Cn + 1
0n

In May 2000 , the GSI successfully repeated the experiment to synthesize a further atom of copernicium @-@ 277 . This reaction was repeated at RIKEN using the Search for a Super @-@ Heavy Element Using a Gas @-@ Filled Recoil Separator set @-@ up in 2004 and 2013 to synthesize three further atoms and confirm the decay data reported by the GSI team .

The IUPAC / IUPAP Joint Working Party (JWP) assessed the claim of discovery by the GSI team in 2001 and 2003 . In both cases , they found that there was insufficient evidence to support their claim . This was primarily related to the contradicting decay data for the known nuclide rutherfordium @-@ 261 . However , between 2001 and 2005 , the GSI team studied the reaction 248Cm (26Mg , 5n) 269Hs , and were able to confirm the decay data for hassium @-@ 269 and rutherfordium @-@ 261 . It was found that the existing data on rutherfordium @-@ 261 was for an isomer , now designated rutherfordium @-@ 261m .

In May 2009 , the JWP reported on the claims of discovery of element 112 again and officially recognized the GSI team as the discoverers of element 112 . This decision was based on the confirmation of the decay properties of daughter nuclei as well as the confirmatory experiments at RIKEN .

= = = Naming = = =

Using Mendeleev 's nomenclature for unnamed and undiscovered elements , copernicium should be known as eka @-@ mercury . In 1979 , IUPAC published recommendations according to which the element was to be called ununbium (with the corresponding symbol of Uub) , a systematic element name as a placeholder , until the element was discovered (and the discovery then confirmed) and a permanent name was decided on . Although widely used in the chemical community on all levels , from chemistry classrooms to advanced textbooks , the recommendations were mostly ignored among scientists in the field , who either called it " element 112 " , with the symbol of (112) or even simply 112 .

After acknowledging the GSI team 's discovery , the IUPAC asked them to suggest a permanent name for element 112 . On 14 July 2009 , they proposed copernicium with the element symbol Cp , after Nicolaus Copernicus " to honor an outstanding scientist , who changed our view of the world " .

During the standard six @-@ month discussion period among the scientific community about the naming , it was pointed out that the symbol Cp was previously associated with the name cassiopeium (cassiopium) , now known as lutetium (Lu) . For this reason , the IUPAC disallowed the use of Cp as a future symbol , prompting the GSI team to put forward the symbol Cn as an alternative . On 19 February 2010 , the 537th anniversary of Copernicus ' birth , IUPAC officially accepted the proposed name and symbol .

= = Isotopes = =

Copernicium has no stable or naturally @-@ occurring isotopes . Several radioactive isotopes have been synthesized in the laboratory , either by fusing two atoms or by observing the decay of heavier elements . Six different isotopes have been reported with atomic masses from 281 to 285 , and 277 , two of which , copernicium @-@ 283 and copernicium @-@ 285 , have known metastable states . Most of these decay predominantly through alpha decay , but some undergo spontaneous fission .

The isotope copernicium @-@ 283 was instrumental in the confirmation of the discoveries of the elements flerovium and livermorium .

= = = Half @-@ lives = = =

All copernicium isotopes are extremely unstable and radioactive ; in general , heavier isotopes are more stable than the lighter . The most stable isotope , 285Cn , has a half @-@ life of 29 seconds , although it is suspected that this isotope has an isomer with a half @-@ life of 8 @.@ 9 minutes , and 283Cn may have an isomer with a half @-@ life of about 5 minutes . Other isotopes have half @-@ lives shorter than 0 @.@ 1 seconds . 281Cn and 284Cn both have half @-@ lives of 97 ms , and the other two isotopes have half @-@ lives slightly under one millisecond . It is predicted that the heavy isotopes 291Cn and 293Cn may have half @-@ lives of around 1200 years , and may have been produced in the r @-@ process and be detectable in cosmic rays , though they would be about 10 ? 12 times as abundant as lead .

The lightest isotopes were synthesized by direct fusion between two lighter nuclei and as decay products (except for 277Cn , which is not known to be a decay product) , while the heavier isotopes are only known to be produced by decay of heavier nuclei . The heaviest isotope produced by direct fusion is 283Cn ; the two heavier isotopes , 284Cn and 285Cn have only been observed as decay products of elements with larger atomic numbers . In 1999 , American scientists at the University of California , Berkeley , announced that they had succeeded in synthesizing three atoms of 293Uuo . These parent nuclei were reported to have successively emitted three alpha particles to form copernicium @-@ 281 nuclei , which were claimed to have undergone an alpha decay , emitting an alpha particle with decay energy of 10 @.@ 68 MeV and half @-@ life 0 @.@ 90 ms , but their claim was retracted in 2001 . The isotope , however , was produced in 2010 by the same team . The new data contradicted the previous (fabricated) data .

= = Predicted properties = =

= = = Chemical = = =

Copernicium is the last member of the 6d series of transition metals and the heaviest group 12 element in the periodic table , below zinc , cadmium and mercury . It is predicted to differ significantly from the lighter group 12 elements . Due to stabilization of 7s electronic orbitals and destabilization of 6d ones caused by relativistic effects , Cn2 + is likely to have a [Rn] 5f146d87s2 electronic configuration , using the 6d orbitals before the 7s one , unlike its homologues . The fact that the 6d electrons participate readily in chemical bonding mean that copernicium should behave more like a transition metal than its lighter homologues , especially in the + 4 oxidation state . In water solutions , copernicium is likely to form the + 2 and + 4 oxidation states , with the latter one being more stable . Among the lighter group 12 members , for which the + 2 oxidation state is the most common , only mercury can show the + 4 oxidation state , but it is highly uncommon , existing at only one compound (mercury (IV) fluoride , HgF4) at extreme conditions . The analogous compound for copernicium , copernicium (IV) fluoride (CnF4) , is predicted to be more stable . The diatomic ion Hg2 +
2 , featuring mercury in the + 1 oxidation state , is well @-@ known , but the Cn2 +
2 ion is predicted to be unstable or even non @-@ existent . Oxidation of copernicium from its neutral state is also likely to be more difficult than those of previous group 12 members . Copernicium (II) fluoride , CnF2 , should be more unstable than the analogous mercury compound , mercury (II) fluoride (HgF2) , and may even decompose spontaneously into its constituent elements . In polar solvents , copernicium is predicted to preferentially form the CnF ?
5 and CnF ?
3 anions rather than the analogous neutral fluorides (CnF4 and CnF2 , respectively) , although the analogous bromide or iodide ions may be more stable towards hydrolysis in aqueous solution . The anions CnCl2 ?
4 and CnBr2 ?
4 should also be able to exist in aqueous solution .
The valence s @-@ subshells of the group 12 elements and period 7 elements are expected to be relativistically contracted most strongly at copernicium . This and the closed @-@ shell configuration of copernicium result in it probably being a very noble metal . Its metallic bonds should also be very weak , possibly making it extremely volatile , like the noble gases , and potentially making it gaseous at room temperature . However , it should be able to form metal ? metal bonds with copper , palladium , platinum , silver , and gold ; these bonds are predicted to be only about 15 ? 20 kJ / mol weaker than the analogous bonds with mercury .

= = = Physical and atomic = = =

Copernicium should be a very heavy metal with a density of around 23 @.@ 7 g / cm3 in the solid state ; in comparison , the most dense known element that has had its density measured , osmium , has a density of only 22 @.@ 61 g / cm3 . This results from copernicium 's high atomic weight , the lanthanide and actinide contractions , and relativistic effects , although production of enough copernicium to measure this quantity would be impractical , and the sample would quickly decay . However , some calculations predict copernicium to be a gas at room temperature , the first gaseous metal in the periodic table (the second being flerovium) , due to the closed @-@ shell electron configurations of copernicium and flerovium . The atomic radius of copernicium is expected to be around 147 pm . Due to the relativistic stabilization of the 7s orbital and destabilization of the 6d orbital , the Cn + and Cn2 + ions are predicted to give up 6d electrons instead of 7s electrons , which is the opposite of the behavior of its lighter homologues .