

**NAME**

*ciaaw* - library for isotopic abundances and standard atomic weights

**LIBRARY**

*ciaaw* (-libciaaw, -lciaaw)

**SYNOPSIS**

```
use ciaaw
include "ciaaw.h"
import pyciaaw
```

**DESCRIPTION**

*ciaaw* is a Fortran library providing the standard and abridged atomic weights, the isotopic abundance and the isotopes' standard atomic weights. The data are taken from <http://ciaaw.org>. C API allows usage from C, or can be used as a basis for other wrappers. Python wrapper allows easy usage from Python.

What have been implemented:

- o **SAW** Standard Atomic Weights.
- o **ICE** Isotopic Composition of the Element
- o **NAW** Nuclides Atomic Weight.

The latest standard atomic weights were released in 2021 by the *ciaaw* (<https://www.ciaaw.org>). All the values for the atomic weights are provided as double precision reals. The standard atomic weights (or relative atomic mass),  $A_r(E)$ , are extracted from table 1 from Prohaska et al. (IUPAC Technical Report **94**(5):573–600). For the elements that feature an interval for the standard atomic weight, the mean value and the uncertainty are computed using formulas defined in [2]. The standard atomic weights are a dimensionless quantity and thus they need to be multiplied by the molar mass constant Mu in order to get the value in g.mol-1. See codata for physical constants.

The latest isotopic compositions were released in 2013 by the *ciaaw* (<https://www.ciaaw.org>). All the values for the compositions are provided as double precision reals. The isotopic compositions of the element, are extracted from table 1 from Meija et al. (IUPAC Technical Report. **88**(3):293–306).

The latest atomic weights for nuclides were released in 2020 by *ciaaw* <https://www.ciaaw.org> from Huang et al. (AME 2020 **45**(3):030002). All the values for the nuclide atomic weights are provided as double precision reals.

Fortran API

- o **function get\_version(result(fptr))**  
Get the version
- o **character(len=:), pointer :: fptr**  
Fortran pointer to a string indicating the version..
- o **function get\_saw(s, abridged, uncertainty)result(res)**  
Get the standard atomic weight for the element s.
- o **character(len=\*), intent(in) :: s**  
Element symbol.
- o **logical, intent(in), optional :: abridged**  
Set to False if the abridged value is not desired. Default to TRUE.
- o **logical, intent(in), optional :: uncertainty**  
Set to True if the uncertainty is desired. Default to FALSE.
- o **real(dp) :: res**  
NaN if the provided element is incorrect or **-1** if the element does not have a SAW.

**o function get\_ice(s, A, uncertainty)result(res)**  
Get the isotopic composition of the element s for the mass number A.

**o character(len=\*), intent(in) :: s**  
Element symbol.

**o integer(int32), intent(in) :: A**  
Mass number.

**o logical, intent(in), optional :: uncertainty**  
Set to True if the uncertainty is desired. Default to FALSE.

**o real(dp) :: res**  
NaN if the provided element or the mass number A are incorrect or -1 if the element does not have an ICE.

**o function get\_nice(s)result(res)**  
Get the number of isotopes in ICE of the element s.

**o character(len=\*), intent(in) :: s**  
Element symbol.

**o integer(int32) :: res**  
>0 if found or -1 if not found.

**o function get\_naw(s, A, uncertainty)result(res)**  
Get the atomic weight of the nuclide s for the mass number A.

**o character(len=\*), intent(in) :: s**  
Element symbol.

**o integer(int32), intent(in) :: A**  
Mass number.

**o logical, intent(in), optional :: uncertainty**  
Flag for returning the uncertainty instead of the value. Default to FALSE.

**o real(dp) :: res**  
NaN if the provided element or A are incorrect or -1 if the element does not have an NAW.

**o function get\_nnaw(s)result(res)**  
Get the number of nuclides in NAW of the element s.

**o character(len=\*), intent(in) :: s**  
Element symbol.

**o integer(int32) :: res**  
>0 if found or -1 if not found.

## C API

- char\* **ciaaw\_get\_version(void)**
- double **ciaaw\_get\_saw(char \*s, int n, bool abridged, bool uncertainty)**
- double **ciaaw\_get\_ice(char \*s, int n, int A, bool uncertainty)**
- int **ciaaw\_get\_nice(char \*s, int n)**
- double **ciaaw\_get\_naw(char \*s, int n, int A, bool uncertainty)**
- int **ciaaw\_get\_nnaw(char \*s, int n)**

## Python wrappers

- **get\_saw(s: str, abridged: bool=True, uncertainty: bool=False)->float**

- **get\_ice**(s:str, A:int, uncertainty: bool=False)->float
- **get\_nice**(s:str)->int
- **get\_naw**(s:str, A:int, uncertainty: bool=False)->float
- **get\_nnaw**(s:str)->int

**NOTES**

To use *ciaaw* within your fpm project, add the following to your fpm.toml file:

```
[dependencies]
iapws = { git="https://github.com/MilanSkocic/ciaaw.git" }
```

dp stands for double precision and it is an alias to real64 from the iso\_fortran\_env module.

The definitions of the acronyms:

- o ASA** Abridged Standard Atomic Weight
- o SAW** Standard Atomic Weight
- o ICE** Isotopic Composition of the Element
- o NAW** Nuclide Atomic Weight
- o U** Uncertainty

The definitions of the common variables:

- o s** Element
- o Z** Atomic number
- o A** Mass number
- o u** Uncertainty
- o ab** Abridged
- o res** Return values

**EXAMPLES**

Example in Fortran:

```
program example_in_f
use ciaaw
implicit none

character(len=8) :: s

! ASA = Abridged Standard Atomic Weight
! SAW = Standard Atomic Weight
! ICE = Isotopic Composition of the Element
! NAW = Nuclide Atomic Weight
! U = Uncertainty

print '(A)', '##### CIAAW VERSION #####'
print *, "version ", get_version()

print '(A)', '##### CIAAW SAW #####'
print '(A10, F10.5)', 'ASA H = ', get_saw("H", abridged=.true.)
print '(A10, F10.5)', 'U ASA H = ', get_saw("H", uncertainty=.true.)
print '(A10, F10.5)', 'SAW H = ', get_saw("H", abridged = .false.)
print '(A10, F10.5)', 'U SAW H = ', get_saw("H", abridged = .false., un
```

```

print '(A10, F10.5)', 'ASAW T      = ', get_saw("Tc", abridged=.true.)

print '(A)', '##### CIAAW ICE #####'
print '(A, I3)', 'N ICE H      = ', get_nice("H")
print '(A, F12.6)', 'ICE H 1     = ', get_ice("H", A=1)
print '(A, ES23.16)', 'U ICE H 1   = ', get_ice("H", A=1, uncertainty=.true.)
print '(A, F12.6)', 'ICE H 2     = ', get_ice("H", A=2)
print '(A, ES23.16)', 'U ICE H 2   = ', get_ice("H", A=2, uncertainty=.true.)
print '(A, I3)', 'N ICE Tc    = ', get_nice("Tc")
print '(A, I3)', 'N ICE C     = ', get_nice("C")

print '(A)', '##### CIAAW NAW #####'
print '(A, ES23.16)', 'NAW H 2     = ', get_naw("H", A=2)
print '(A, ES23.16)', 'U NAW H 2   = ', get_naw("H", A=2, uncertainty=.true.)
print '(A, I3)', 'N NAW Tc    = ', get_nnaw("Tc")

end program

```

Example in C:

```

#include <stdlib.h>
#include <stdio.h>
#include <string.h>
#include <stdbool.h>
#include "ciaaw.h"

// ASAW = Abridged Standard Atomic Weight
// SAW  = Standard Atomic Weight
// ICE  = Isotopic Composition of the Element
// NAW  = Nuclide Atomic Weight
// U    = Uncertainty

int main(void){
printf("%s0, ##### CIAAW VERSION #####");
printf("version %s0, ciaaw_get_version());

printf("%s0, ##### CIAAW SAW #####");
printf("%s %10.5f0, "ASAW H    = ", ciaaw_get_saw("H", 1, true, false));
printf("%s %10.5f0, "U ASAW H = ", ciaaw_get_saw("H", 1, true, true));
printf("%s %10.5f0, "SAW H     = ", ciaaw_get_saw("H", 1, false, false));
printf("%s %10.5f0, "U SAW H   = ", ciaaw_get_saw("H", 1, false, true));
printf("%s %10.5f0, "ASAW Tc   = ", ciaaw_get_saw("Tc", 2, true, false));

printf("%s0, ##### CIAAW ICE #####");
printf("%s %d0,      "N ICE H      = ", ciaaw_get_nice("H", 1));
printf("%s %12.6f0,   "ICE H 1     = ", ciaaw_get_ice("H", 1, 1, false));
printf("%s %23.16e0, "U ICE H 1   = ", ciaaw_get_ice("H", 1, 1, true));
printf("%s %12.6f0,   "ICE H 2     = ", ciaaw_get_ice("H", 1, 2, false));
printf("%s %23.16e0, "U ICE H 2   = ", ciaaw_get_ice("H", 1, 2, true));
printf("%s %d0,       "N ICE Tc    = ", ciaaw_get_nice("Tc", 2));
printf("%s %d0,       "N ICE C     = ", ciaaw_get_nice("C", 1));

printf("%s0, ##### CIAAW NAW #####");
printf("%s %23.16f0,  "NAW H 2     = ", ciaaw_get_naw("H", 1, 2, false));

```

```

printf("%s %23.16e0, "U NAW H 2      = ", ciaaw_get_naw("H", 1, 2, true));
printf("%s %d0,        "N NAW Tc      = ", ciaaw_get_nnaw("Tc", 2));
return EXIT_SUCCESS;
}

```

Example in Python:

```

import pyciaaw

# ASA = Abridged Standard Atomic Weight
# SA = Standard Atomic Weight
# IC = Isotopic Composition of the Element
# NA = Nuclide Atomic Weight
# U = Uncertainty

print("##### CIAAW VERSION #####")
print("version ", pyciaaw.__version__)

print("##### CIAAW SA = #####")
print("ASA H = ", pyciaaw.get_saw("H"))
print("U ASA H = ", pyciaaw.get_saw("H", uncertainty=True))
print("SA H = ", pyciaaw.get_saw("H", abridged=False, uncertainty=False))
print("U SA H = ", pyciaaw.get_saw("H", abridged=False, uncertainty=True))
print("ASA Tc = ", pyciaaw.get_saw("Tc"))

print("##### CIAAW IC = #####")
print("N IC H = ", pyciaaw.get_nice("H"))
print('IC H 1 = ', pyciaaw.get_ic("H", A=1))
print('U IC H 1 = ', pyciaaw.get_ic("H", A=1, uncertainty=True))
print('IC H 2 = ', pyciaaw.get_ic("H", A=2))
print('U IC H 2 = ', pyciaaw.get_ic("H", A=2, uncertainty=True))
print("N IC Tc = ", pyciaaw.get_nice("Tc"))
print("N IC C = ", pyciaaw.get_nice("C"))

print("##### CIAAW NA = #####")
print('NA H 2 = ', pyciaaw.get_naw("H", A=2))
print('U NA H 2 = ', pyciaaw.get_naw("H", A=2, uncertainty=True))
print("N NA Tc = ", pyciaaw.get_nnaw("Tc"))

```

## SEE ALSO

[gsl\(3\)](#), [codata\(3\)](#)