A Quick Guide to `astropy.units`

astropy.units is an integral aspect to using PlasmaPy and can overall make your scientific coding more clear, readable, and error-free

Installing astropy.units and astropy.constants:

astropy can be installed with the following command:

```
python -m pip install astropy
```

astropy.units and astropy.constants can be imported using:

```
import astropy.units as u
from astropy import constants
```

If using an online notebook like Google Colab, you can install astropy and other necessary modules using the following code:

```
[ ] %matplotlib inline

    import sys

    if 'google.colab' in str(get_ipython()):
        if 'plasmapy' not in sys.modules:
            !pip install astropy matplotlib numpy

    import astropy.units as u
    from astropy.visualization import quantity_support
    from astropy import constants
    import matplotlib.pyplot as plt
    import numpy as np
```

Using astropy.units:

The main use of astropy.units is to associate a specific unit to a variable in your code. For example, we can create a variable (called a Quantity) called distance which is associated with units of kilometers:

```
[1]  distance = 60 * u.km
```

Printing this quantity returns a variable that has the value of 60 and the units of kilometers:

```
60.0 km
```

You can create new Quantities with units based on existing astropy.units Quantities:

```
[12] distance = 60 * u.km
     time = 2 * u.min
     velocity = distance / time
     print(velocity)
```

```
30.0 km / min
```

astropy.units can prevent you from doing operations using Quantities with incompatible units

```
[ ] 3 * u.m + 3 * u.s
```

```
---------------------------------------------------------------------------
UnitConversionError                       Traceback (most recent call last)
File /run/media/namurphy/d423d80e-c227-4a33-b50f-545b44160ce3/namurphy/Applic
packages/astropy/units/quantity_helper/helpers.py:77, in get_converters_and_u
     76 try:
---> 77     converters[changeable] = get_converter(unit2, unit1)
     78 except UnitsError:
```

Flip to page 2

List of astropy.units and astropy.constants:

Below are lists of various units and their symbol within astropy.units. The standard units included are SI, CGS, and astrophysical units. Some units are irreducible (like length, time, and mass), while others are composite (made combinations of units like m/s or N/C), Imperial units are included, but in order to use imperial units, you must enable them:

```
from astropy.units import imperial
imperial.enable()
```

Lengths

u.m – meters
u.km – kilometers
u.cm – centimeters
u.mm – milimeters
u.um – micrometers
u.micron - micrometers
u.nm - nanometers
u.AU – astronomical units
u.Angstrom – angstroms
u.lsec – light seconds
u.lyr – light years
u.pc – parsecs
u.ft – foot
u.inch – inch
u.mi – mile
u.yd – yard

Energy

u.J – Joule
u.BTU – BTU
u.eV – electron volt
u.erg – Ergs
u.cal – calorie
u.kcal – Calorie, kilocalorie

Times

u.s – seconds
u.second – seconds
u.d – day
u.day – day
u.hr – hour
u.hour – hour
u.min – minute
u.wk – week
u.yr - year

Force

u.N – Newton
u.dyne – dyne

Potential

u.V - volt

Charge

u.C – Coulombs

Capacitance

u.F – Farad

Masses

u.g – gram
u.kg – kilogram
u.lb – pound
u.oz – ounce

Current

u.A – current
u.C/u.s – charge/coulomb

Temperature

u.K – Kelvin
u.deg_C – Celsius

Magnetic Field

u.G – Gauss
u.T - Tesla

Electric Field

u.N/u.C – Newtons/Coulomb
u.V/u.m – Volt/meter

Pressure

u.Pa – Pascal
u.Torr – torr

Area and Volume

u.m**2 – meters^2
u.m**3 – meters^3

Velocity

u.m/u.s – meters/second
u.mi/u.hr – mph

Density

u.kg/u.m**3 – mass density
u.m**-3 – number density

Constants (all in SI units)

G – gravitational constant
N_A – Avogadro's Number
R – Gas Constant
Ryd – Rydberg Constant
a0 – Bohr radius
alpha – fine structure constant
atm – standard atmosphere
c – speed of light
e – electron charge
eps0 – vacuum electric permittivity
h – Planck's constant
hbar – reduced Planck's constant
k_B – Boltzman's constant
m_e – electron mass
m_n – neutron mass
m_p – proton mass
mu0 – vacuum magnetic permeability
muB – Bohr magneton
u – atomic mass
sigma_T – Thomson scattering cross-sec
sigma_sb – Stefan-Boltzman constant
M_earth – Earth mass
M_sun – Solar mass
R_earth – Earth radius
R_sun – Solar radius
au – astronomical unit