
pylorentz Documentation

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The python package `pylorentz` provides classes to facilitate computations with 4-vectors in high-energy physics.

CHAPTER 1

Quickstart

Install the package using pip

```
$ pip install git+https://gitlab.sauerburger.com/frank/pylorentz.git
```

or

```
$ pip install pylorentz
```

1.1 Properties

The package defines three types of 4-vectors: general purpose vectors, 4-positions and 4-momenta. The working horse of the package are 4-momenta.

```
>>> from pylorentz import Momentum4
>>> muon = Momentum4.m_eta_phi_pt(0.1057, 4.5, 1.5, 35)
>>> muon.eta
4.5
>>> muon.phi
1.5
>>> muon.p_t
35.0
>>> "%.2f" % muon.p
'1575.49'
>>> "%.2f" % muon.e
'1575.49'
```

1.1.1 Vectorized Properties

Since version 0.2.0, it is possible to pass numpy arrays to the constructors and operate on multiple vectors at a time.

```
>>> from pylorentz import Momentum4
>>> import numpy as np
>>> masses = np.array([0.0005, 0.1057, 1.7769])
>>> etas = np.array([1, 2, 3])
>>> phis = np.array([0, 0, 0])
>>> pts = np.array([10, 10, 10])
>>> muon = Momentum4.m_eta_phi_pt(masses, etas, phis, pts)
>>> ["%.2f" % m for m in muon.e]
['15.43', '37.62', '100.69']
```

1.2 Arithmetics

4-vectors support a variety of arithmetic operations. The most important one is the addition of two vectors.

```
>>> from pylorentz import Momentum4
>>> tau_1 = Momentum4.m_eta_phi_pt(1.777, 4.5, 1.5, 35)
>>> tau_2 = Momentum4.m_eta_phi_pt(1.777, -4.5, 1.5, 35)
```

We can add the momenta of the two tau leptons and access the properties of the parent particle.

```
>>> parent = tau_1 + tau_2
>>> "%.2f" % parent.m
'3150.21'
>>> "%.2f" % parent.eta
'0.00'
>>> "%.2f" % parent.phi
'1.50'
```

1.3 Lorentz Boosts

The package also provides methods to perform Lorentz boosts. For example, consider the decay of a Higgs boson to a pair of tau leptons in the rest frame of the Higgs boson. The tau leptons are back-to-back in the y-z-plane.

```
>>> import math
>>> from pylorentz import Momentum4
>>> m = 125.0
>>> tau_1 = Momentum4.e_m_eta_phi(m / 2, 1.777, 1.5, math.pi / 2)
>>> tau_2 = Momentum4.e_m_eta_phi(m / 2, 1.777, -1.5, -math.pi / 2)
```

Now let's assume the Higgs boson itself is not at rest. We can define its momentum and then boost the two tau leptons.

```
>>> higgs = Momentum4.m_eta_phi_pt(m, 2, 0, 250)
>>> tau_1.boost_particle(higgs)
Momentum4(884.599, 220.498, 26.5578, 856.264)
>>> tau_2.boost_particle(higgs)
Momentum4(64.2195, 29.5021, -26.5578, 50.451)
```


CHAPTER 2

Links

- [GitLab Repository](#)
- [pylorentz on PyPi](#)
- [Documentation](#)