Sheet 1

Lena Rathmann 370357
Max Straub 355175

1) $1\,\text{dyn} = 1\,\frac{g\,cm}{s^2} = 10^{-3}\,kg \cdot 10^{-2}\,m \cdot \frac{1}{s^2}$

$= 10^{-5}\,N$

$1\,\text{erg} = 1\,\frac{cm^2 g}{s^2} = 10^{-3}\,kg\,(10^{-2}m)^2\,\frac{1}{s^2}$

$= 10^{-7}\,J$

$1\,\frac{erg}{s} = 10^{-7}\,\frac{J}{s} = 10^{-7}\,W$

2

3.) $\Omega_0 = 0{,}3036$

a.) $H_0 = 68{,}14$ 2.1

z	Mpc
0,01	44,58
0,1	476,48
1	6775,56

-0,5 2.2

Up to about $z = 0{,}1$ the linear Hubble law still produces 2.3 usable results.

home.fnal.gov/~gnedin/cc/

b.) $1\,kpc = 3262\,lyr$ (from Wolfram alpha)

$1\,Mpc = 3262 \cdot 10^3\,lyr$?

c.) $\frac{c}{H_0} \cdot z = 2359 \text{ Mpc}$ $\boxed{H_0 = 68.14}$

Luminosity distance: 3168 Mpc
(with tool and values from previous exercise)

Proper distance:

$$d_e = \frac{d_L}{(1+z)} = 2062 \text{ Mpc}$$

4,5

4)

a) $S_E = E \cdot \frac{d\Phi(E)}{dE}$

b) $\frac{d\Phi(E)}{dE} = \Phi_0 E^{-\gamma}$

$\Rightarrow \Phi(E) = \int_E^\infty \Phi_0 E'^{-\gamma} dE' = \left[\frac{\Phi_0}{-\gamma+1} E'^{-\gamma+1}\right]_E^\infty$

$= \frac{\Phi_0}{(\gamma-1)} E^{-(\gamma-1)}$

$\Rightarrow \alpha = \gamma - 1 , \quad \bar{\Phi}_0 = \frac{\Phi_0}{(\gamma-1)}$

c) $S = \int_E^\infty E \cdot \frac{d\Phi(E)}{dE} dE = \int_E^\infty (\gamma-1)\, \Phi(E)\, dE$ −0,5

d) $\Psi(E) = E \frac{d\Phi(E)}{dE} = (\gamma-1)\, \Phi(E) = \frac{(\gamma-2)}{E} S(E)$ $= S_E$

e) $\left[\frac{d\Phi(E)}{dE}\right] = s^{-1} cm^{-2} sr^{-1} GeV^{-1}$ describes the flux of particles for a specific energy intervall dE.

$[\Phi(E)] = s^{-1} cm^{-2} sr^{-1}$ describes the flux of particles starting at an energy of E to infinity.

$[S_E] = s^{-1} cm^{-2} sr^{-1}$ describes the flux of energy for a specific energy intervall dE.

$[S] = s^{-1} cm^{-2} sr^{-1} GeV$ describes the integrated flux of energy starting from E to infinity.

$[\Psi(E)] = s^{-1} cm^{-2} sr^{-1}$ describes a flux of particles.

f) 1st case: $[\Phi_0] = s^{-1} cm^{-1} sr^{-1} GeV^{\gamma-1}$ −0,5

$[\bar{\Phi}_0] = s^{-1} cm^{-1} sr^{-1} GeV^{\gamma-1} = [S_0] = [\Psi_0]$

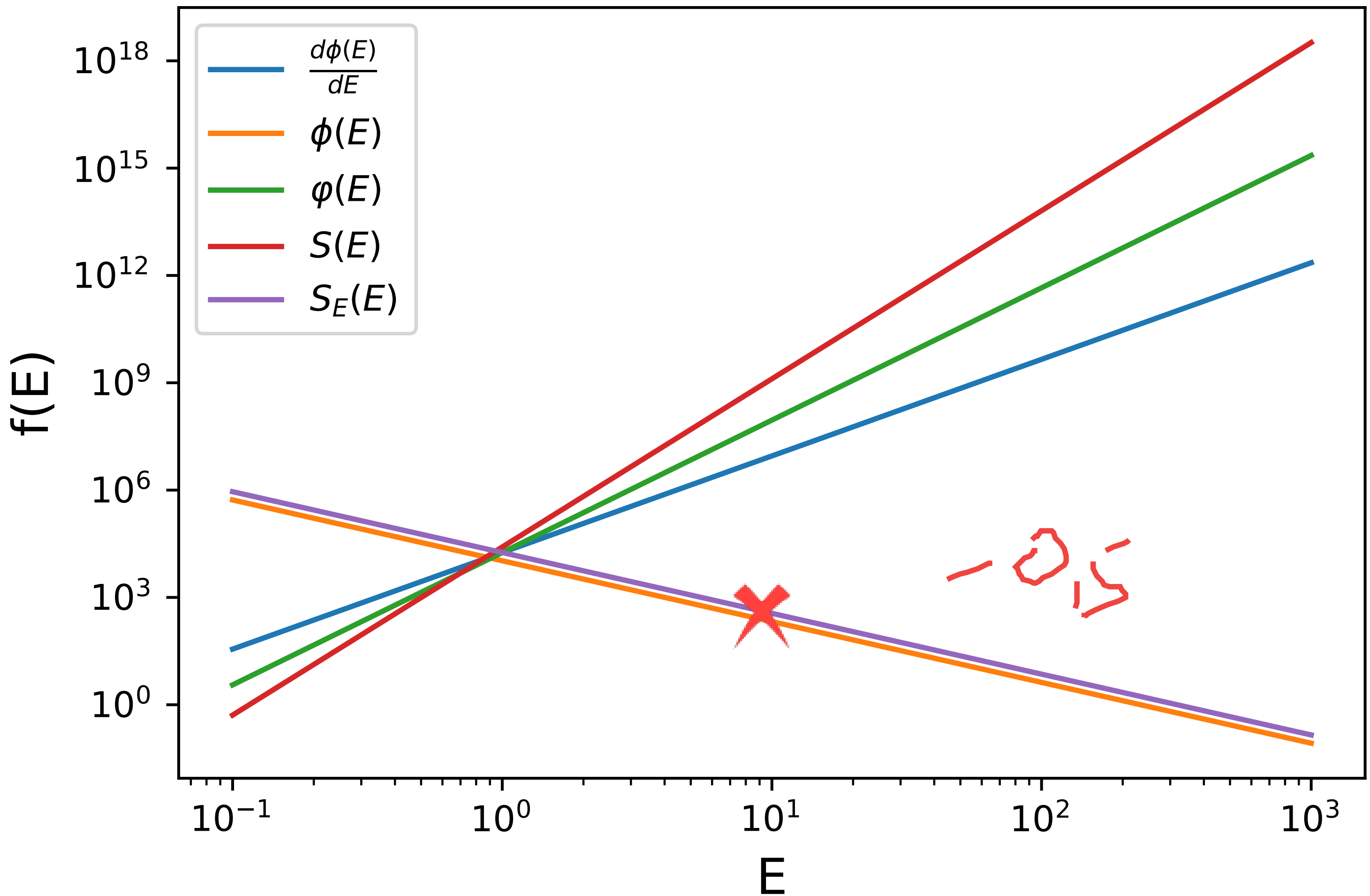
2nd case: $[\Phi_0] = s^{-1} cm^{-1} sr^{-1} GeV^{-1}$

$[\bar{\Phi}_0] = s^{-1} cm^{-1} sr^{-1} = [\Psi_0]$

$[S_0] = s^{-1} cm^{-1} sr^{-1} GeV$

6,5

g)



$\frac{d\phi(E)}{dE}$
$\phi(E)$
$\varphi(E)$
$S(E)$
$S_E(E)$
10^{18}
10^{15}
10^{12}
10^{9}
10^{6}
10^{3}
10^{0}
f(E)
10^{-1}
10^{0}
10^{1}
10^{2}
10^{3}
E
-0,5

Sheet 1, Task 2

Rathmann, Straub

In [37]:

```
import astropy.units as u
```

Define Custom Units:

In [ ]:

```
GU = u.def_unit("GU", 8.2e3 * u.parsec)
SU = u.def_unit("SU", 4.244 * u.lyr)
```

GU is the "Galactic Unit"[1], SU is the "Stellar Unit"[2].

In [34]:

```
dia_milky = 710e3*u.parsec # diameter of milky way [3]
canis_major = 25e3*u.lyr # distance to nearest galaxy, canis major [4]
markarian = 140e6*u.parsec # distance to blazar markarian 501 [5]
quasar = 13.1e9*u.lyr # distance to most distant known quasar ULAS J1342+0928 [6]
```

In [35]:

```
for dist in [dia_milky, canis_major, markarian, quasar]:
    print(dist.to(u.m))
    print(dist.to(GU))
    print(dist.to(SU))
    print("_"*10)
```

```
2.190831082841706e+22 m
86.58536585365853 GU
545643.3274671854 SU
__________
2.3651826181452e+20 m
0.9347603469144901 GU
5890.66918001885 SU
__________
4.3199486140540683e+24 m
17073.170731707316 GU
107591642.03578304 SU
__________
1.2393556919080848e+26 m
489814.4217831928 GU
3086710650.3298774 SU
__________
```

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References

1: doi:10.1017/S1743921312021060

2: doi:10.1007/978-3-642-22839-1_10

3: https://www.sciencenews.org/article/astronomers-have-found-edge-milky-way-size (https://www.sciencenews.org/article/astronomers-have-found-edge-milky-way-size)

4: https://imagine.gsfc.nasa.gov/features/cosmic/nearest_galaxy_info.html (https://imagine.gsfc.nasa.gov/features/cosmic/nearest_galaxy_info.html)

5: https://en.wikipedia.org/wiki/Markarian_501 (https://en.wikipedia.org/wiki/Markarian_501) (couldn't find a better source, sorry)

6: https://www.space.com/39000-oldest-farthest-monster-black-hole-yet.html (https://www.space.com/39000-oldest-farthest-monster-black-hole-yet.html)

In [ ]:

```

```

Index der Kommentare

2.1 unit

2.2 values too large. where are the calculated values?

2.3 up to z=0.4-0.5

4.1 incomplete

4.2 differential flux

4.3 integrated particle flux

4.4 energy weighted particle flux, differential

6.1 visible diameter is 30kpc

6.2 it is a dwarf galaxy, not a galaxy. the nearest is Andromeda

6.3 this is light traveled distance, not proper distance