GammaLib - Action #392

Feature # 34 (Closed): Implement MC methods for all spectral models

Implement MC method for GModelSpectralExpPlaw

07/28/2012 01:02 AM - Knödlseder Jürgen

Status:	Closed	**Start date:**	02/20/2012
Priority:	Normal	**Due date:**	
Assigned To:	Knödlseder Jürgen	**% Done:**	100%
Category:		**Estimated time:**	4.00 hours
Target version:	00-08-00		

Description

History

#1 - 09/01/2012 03:49 AM - Knödlseder Jürgen

- Target version deleted (00-06-00)

#2 - 09/14/2012 11:38 PM - Knödlseder Jürgen

- Target version set to 00-07-00

#3 - 12/15/2012 12:15 AM - Knödlseder Jürgen

Here some Python code implementing an exponential cutoff power law random number generator. n is the number of random samples to be drawn, alpha the exponent and Lambda the cutoff value.

```
x = []
y=[]
for i in range(10*n):
    y.append(xmin - (1./Lambda)*log(1.-random()))
while True:
    ytemp=[]
    for i in range(10*n):
        if random()<pow(y[i]/float(xmin),-alpha):ytemp.append(y[i])
    y = ytemp
    x = x+y
    q = len(x)-n
    if q==0: break;

    if (q>0):
        r = range(len(x))
        shuffle(r)

        xtemp = []
        for j in range(len(x)):
            if j not in r[0:q]:
                xtemp.append(x[j])
        x=xtemp
        break;

    if (q<0):
        y=[]
        for j in range(10*n):
            y.append(xmin - (1./Lambda)*log(1.-random()))
```

#4 - 12/15/2012 12:26 AM - Knödlseder Jürgen

Here another code:

```
/*
Simulate power law with cut-off x^(-alpha)*exp(-lambda*x)
To simulate power-law with cutoff , one can generate an
exponentially distributed random number using the formula
above     (as k>0 and integer, so k start at 1)
and then accept or reject it with probability p or 1 - p
respectively (i.e accept U1 <p or reject U1>p, and
 U1 is a uniform [0,1] random variable),
where p = (x/x_min)^(-alpha)  and  x_min=1.

http://www.santafe.edu/~aaronc/powerlaws/
*/
double rand_gen::powerlaw_dist(double alpha, double lamda)
{
  double x;
  do {
    x = exponential_dist(lamda);
  } while (pow(x,-1*alpha) < uniform_dist(0.,1.));
  return (x);
}

/*
To simulate exponential distribution exp(-lambda*x), the inverse
 method is used.
The cumulative distribution function for the exponential
distribution is:1-exp(-lambda*x). The inversion function
is  -log(1-U)/lambda. The simplified form is -log(U)/lambda,
where U is a uniform [0,1] random variable.
 http://cg.scs.carleton.ca/~luc/rnbookindex.html
*/
double rand_gen::exponential_dist(double lambda)
{
  return(-1*log(uniform_dist(0.,1.))/lambda);
}
```

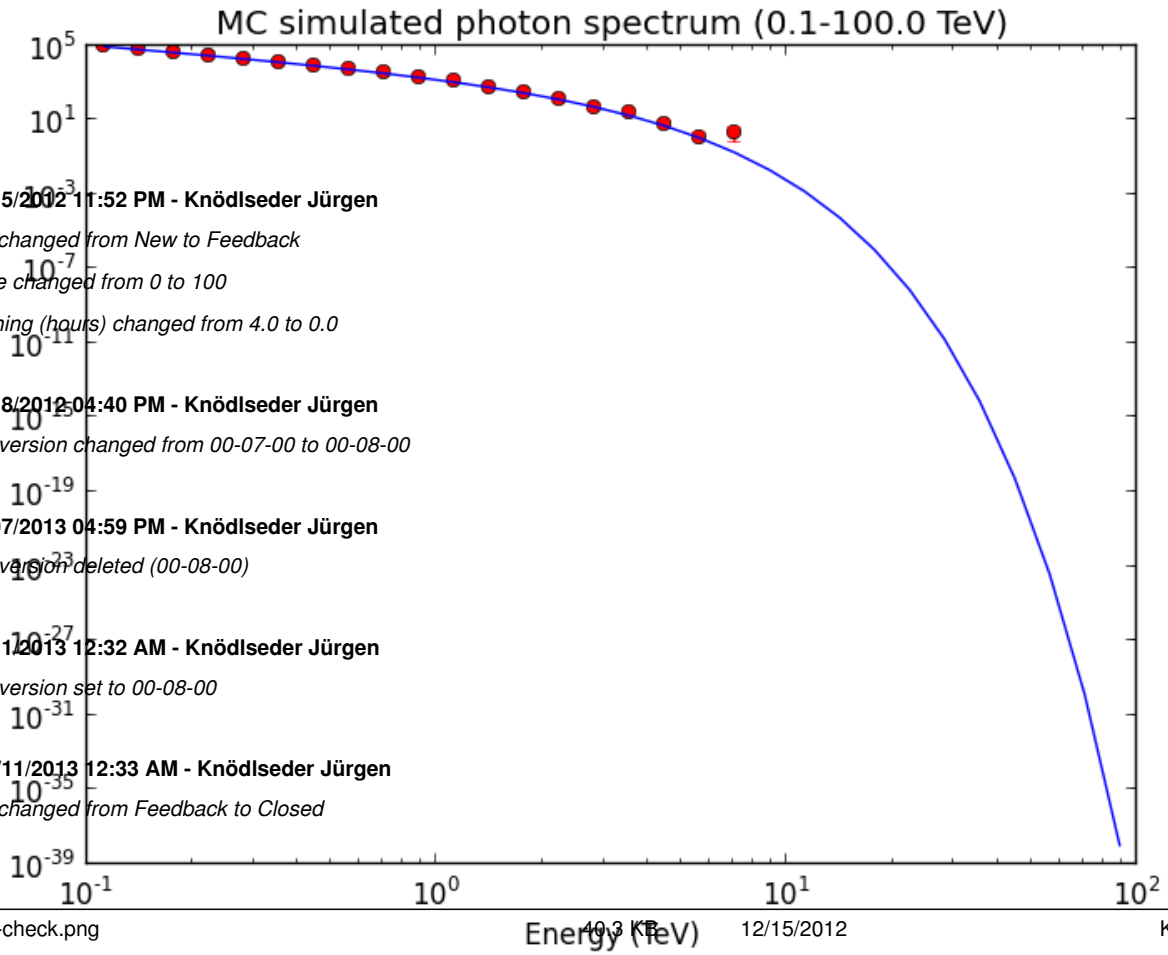
#5 - 12/15/2012 11:51 PM - Knödlseder Jürgen

- File expplaw-check.png added

The method has now been implemented.

The above algorithm has proven to be very inefficient. We now use first the analytical power law MC to draw an energy, and then use a rejection method to see whether we should accept the sample or reject it. This works in a reasonable amount of time.

The following plot shows the simulation results for 5 hours of Crab observations with CTA (269285 photons simulated).



#6 - 12/15/2012 11:52 PM - Knödlseder Jürgen

- Status changed from New to Feedback

- % Done changed from 0 to 100

- Remaining (hours) changed from 4.0 to 0.0

#7 - 12/18/2012 04:40 PM - Knödlseder Jürgen

- Target version changed from 00-07-00 to 00-08-00

#8 - 01/07/2013 04:59 PM - Knödlseder Jürgen

- Target version deleted (00-08-00)

#9 - 01/11/2013 12:32 AM - Knödlseder Jürgen

- Target version set to 00-08-00

#10 - 01/11/2013 12:33 AM - Knödlseder Jürgen

- Status changed from Feedback to Closed

Files

expplaw-check.png	40.3 KB	12/15/2012	Knödlseder Jürgen