{{lastupdated_at}} by {{lastupdated_by}}

GModelSpectralLogParabola

This class allows a spectrum definition with an energy-dependent index. It follows the formula:

{{latex(\frac{dN}{dE} = \Phi\cdot\left(\frac{E}{E_0}\right)^{\alpha+\beta\log{E/E_0}})}}

{{latex(\Phi)}}: Normalisation at reference energy

{{latex(\alpha)}}: Index at reference energy

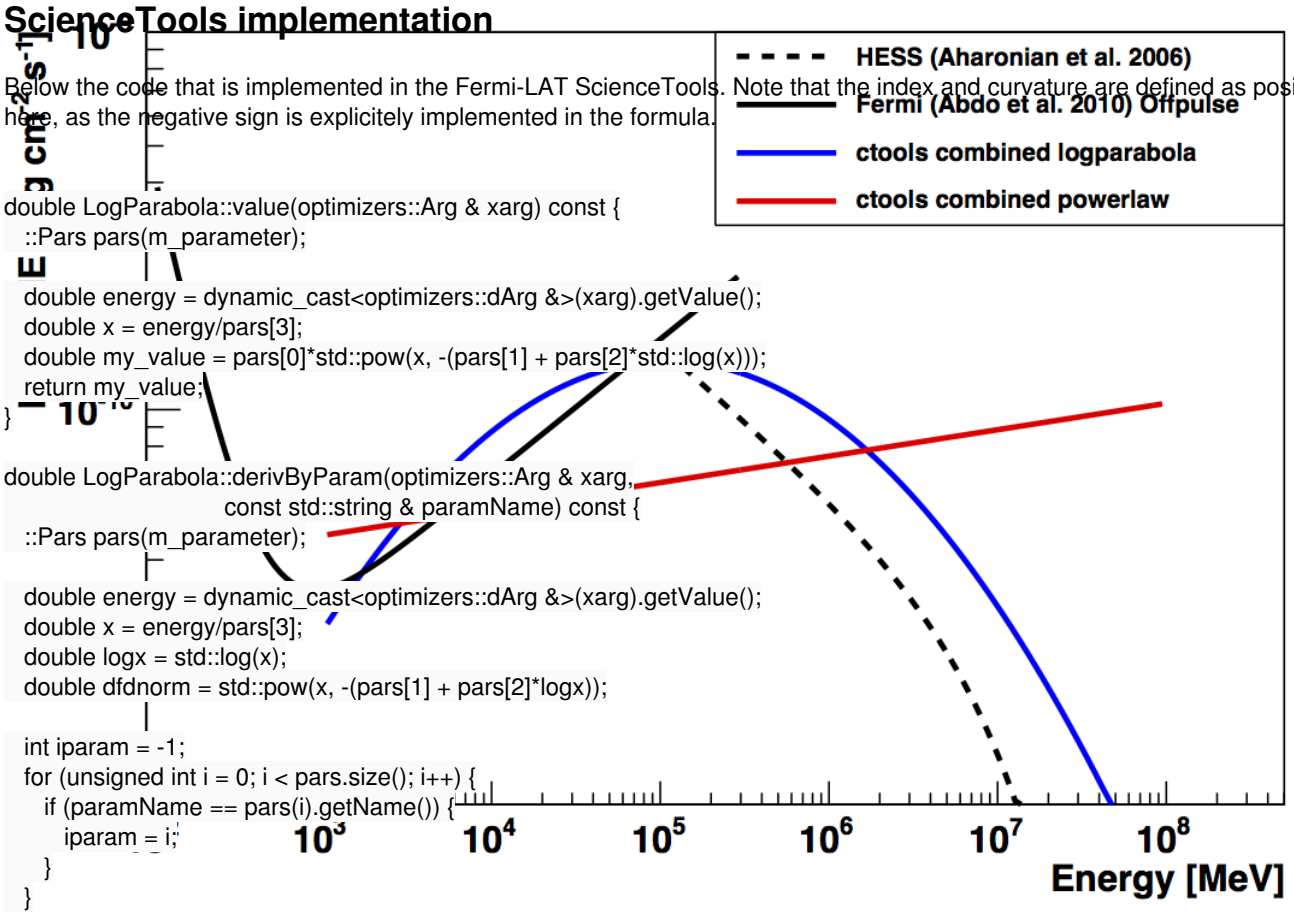
{{latex(\beta)}}: Curvature

{{latex(E_0)}}: Pivot energy (reference energy)

A first test of applying this model to real data from Fermi LAT and HESS is attached.

ScienceTools implementation

Below the code that is implemented in the Fermi-LAT ScienceTools. Note that the index and curvature are defined as positive values here, as the negative sign is explicitely implemented in the formula.




```
double LogParabola::value(optimizers::Arg & xarg) const {
  ::Pars pars(m_parameter);

  double energy = dynamic_cast<optimizers::dArg &>(xarg).getValue();
  double x = energy/pars[3];
  double my_value = pars[0]*std::pow(x, -(pars[1] + pars[2]*std::log(x)));
  return my_value;
}

double LogParabola::derivByParam(optimizers::Arg & xarg,
                                 const std::string & paramName) const {
  ::Pars pars(m_parameter);

  double energy = dynamic_cast<optimizers::dArg &>(xarg).getValue();
  double x = energy/pars[3];
  double logx = std::log(x);
  double dfdnorm = std::pow(x, -(pars[1] + pars[2]*logx));

  int iparam = -1;
  for (unsigned int i = 0; i < pars.size(); i++) {
    if (paramName == pars(i).getName()) {
      iparam = i;
    }
  }

  if (iparam == -1) {
    throw optimizers::ParameterNotFound(paramName, getName(),
                                        "LogParabola::derivByParam");
  }

  enum ParamTypes {norm, alpha, beta, Eb};
  switch (iparam) {
  case norm:
    return dfdnorm*m_parameter[norm].getScale();
  case alpha:
    return -pars[0]*logx*dfdnorm*m_parameter[alpha].getScale();
  case beta:
```

```
    return -pars[0]*logx*logx*dfdnorm*m_parameter[beta].getScale();
  case Eb:
    return value(xarg)/pars[3]*(pars[1] + 2.*pars[2]*logx)
      *m_parameter[Eb].getScale();
  default:
    break;
  }
  return 0;
}
```

Monte Carlo Method

the method GModelSpectralLogParabola::mc(GEnergy emin, GEnergy emax, GRan ran) returns a random energy following the LogParabola distribution. The following plots have been produced using normalised LogParabola with the Parameters index=-2, curvature=+-0.2 and E0=100MeV. 100000 Events have been simulated. Red lines show the underlying LogParabola model while green lines correspond to the respective powerlaws which are used as function for the "rejection sampling method".

Files

fermihess.png	104 KB	01/07/2013	Mayer Michael
negative_curvature.png	38.4 KB	01/11/2013	Mayer Michael
positive_curvature.png	42.2 KB	01/11/2013	Mayer Michael