

{{lastupdated_at}} by {{lastupdated_by}}

GModelSpectralLogParabola

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

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

Φ : Normalisation at reference energy

α : Index at reference energy

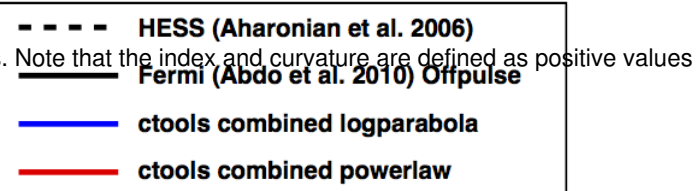
β : Curvature

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 here, as the negative sign is explicitly 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:

```

```
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".

