

```

In[1]:= data =
  {{0.27931, 15.76, 1.07424, 3.87}, {0.837931, 42.49, 2.46665, 4.93},
   {1.39655, 70.03, 3.27774, 10.44}, {1.95517, 105.83, 3.68792, 4.},
   {2.51379, 118.54, 3.84641, 4.}, {3.07241, 126.9, 3.88202, 3.08},
   {3.63103, 140.32, 4.1325, 4.}, {4.18966, 144.27, 5.44853, 4.02},
   {4.74828, 155.65, 7.01228, 5.36}, {5.3069, 149.54, 8.38873, 5.41},
   {5.86552, 150.65, 9.76333, 7.06}, {6.42414, 155.02, 11.1443, 4.66},
   {6.98276, 166.94, 12.5646, 6.}, {7.54138, 167.37, 14.0251, 2.63},
   {8.1, 163.17, 15.4947, 3.32}, {8.65862, 164.38, 16.9319, 2.43},
   {9.21724, 160.2, 18.5489, 5.7}, {9.77586, 164.47, 20.3382, 3.79},
   {10.3345, 172.81, 22.3449, 8.51}, {10.8931, 165.95, 24.5708, 2.},
   {15.3621, 163.72, 52.6146, 10.79}, {15.9207, 173.94, 56.4422, 2.},
   {18.6207, 176.44, 67.7037, 2.8}, {20.6897, 182.08, 68.486, 2.31},
   {22.7586, 184.16, 66.5516, 2.07}, {24.8276, 183.3, 62.8426, 2.05}};

RC = Table[{data[[i, 1]], data[[i, 2]]}, {i, 1, 26}];
  |tabela

Rgas = Table[{data[[i, 1]], data[[i, 3]]}, {i, 1, 26}];
  |tabela

Erro = Table[data[[i, 4]], {i, 1, 26}];
  |tabela

TableForm[data,
  |forma de tabela
  TableHeadings -> {"ESO 287-G13"}, {"Raio", "Vtotal", "Vgas", "Erro"}]
  |cabeçalhos de tabela

```

Out[5]//TableForm=

	Raio	Vtotal	Vgas	Erro
ESO 287-G13	0.27931	15.76	1.07424	3.87
	0.837931	42.49	2.46665	4.93
	1.39655	70.03	3.27774	10.44
	1.95517	105.83	3.68792	4.
	2.51379	118.54	3.84641	4.
	3.07241	126.9	3.88202	3.08
	3.63103	140.32	4.1325	4.
	4.18966	144.27	5.44853	4.02
	4.74828	155.65	7.01228	5.36
	5.3069	149.54	8.38873	5.41
	5.86552	150.65	9.76333	7.06
	6.42414	155.02	11.1443	4.66
	6.98276	166.94	12.5646	6.
	7.54138	167.37	14.0251	2.63
	8.1	163.17	15.4947	3.32
	8.65862	164.38	16.9319	2.43
	9.21724	160.2	18.5489	5.7
	9.77586	164.47	20.3382	3.79
	10.3345	172.81	22.3449	8.51
	10.8931	165.95	24.5708	2.
	15.3621	163.72	52.6146	10.79
	15.9207	173.94	56.4422	2.
	18.6207	176.44	67.7037	2.8
	20.6897	182.08	68.486	2.31
	22.7586	184.16	66.5516	2.07
	24.8276	183.3	62.8426	2.05

In[6]:= **Igas = Interpolation**[Rgas]
[interpolação]

Out[6]= InterpolatingFunction[



Domain: {{0.279, 24.8}}
Output: scalar
]

In[7]:=

$$\begin{aligned} \text{Vd}[r_ , M_] &:= \frac{1}{2 \text{ Rd}} \left(G (M * 10^9) \left(\frac{r}{\text{Rd}} \right)^2 \right) \\ &\quad \left(\text{BesselI}\left[0, \frac{r}{2 \text{ Rd}}\right] \text{BesselK}\left[0, \frac{r}{2 \text{ Rd}}\right] - \text{BesselI}\left[1, \frac{r}{2 \text{ Rd}}\right] \text{BesselK}\left[1, \frac{r}{2 \text{ Rd}}\right] \right); \\ &\quad \text{[função I de Bessel] [função K de Bessel] [função I de Bessel] [função K de Bessel]} \\ \text{Vme}[r_ , R_ , P_] &:= \frac{1}{r} 6.4 G \left((P * 10^7) R^3 \right) \left(\frac{1}{2} \text{Log}\left[\left(\frac{r}{R}\right)^2 + 1\right] + \text{Log}\left[\frac{r}{R} + 1\right] - \text{ArcTan}\left[\frac{r}{R}\right] \right); \\ &\quad \text{[logaritmo] [logaritmo] [arco tangente]} \\ \text{Vt}[r_ , M_ , R_ , P_] &:= \text{Sqrt}[\text{Vd}[r, M] + \text{Vme}[r, R, P] + \text{Igas}[r]^2]; \\ &\quad \text{[raiz quadrada]} \\ G &:= \frac{4.302}{10^6}; \\ \text{Rd} &:= 3.3; \end{aligned}$$

In[12]:= **Ajuste = NonlinearModelFit**[RC, Vt[r, M, R, P],
[ajusta a um modelo não linear]
{{R, 1, 50}, {M, 1, 30}, {P, 4, 10}}, r, **Weights** → 1/Erro^2]
[pesos]
Ajuste["ParameterTable"]

Out[12]= FittedModel[

$$\sqrt{(2726.76 r^2 (\text{BesselI}[0, 0.151515 r] \text{BesselK}[0, 0.151515 r] - \text{BesselI}[1, 0.151515 r] \text{BesselK}[1, \ll 1 \gg]) + \ll 1 \gg + \ll 1 \gg)}$$
]

	Estimate	Standard Error	t-Statistic	P-Value
R	28.4899	5.9341	4.80105	0.0000764508
M	45.5563	1.26035	36.1458	9.06197×10^{-22}
P	0.430196	0.0775027	5.55072	0.0000120272

Out[13]=

```
Needs["ErrorBarPlots`"];
```

[precisa de](#)

```
RCtotal = Plot[Ajuste[r], {r, 0, 24.82},
```

[gráfico](#)

```
PlotStyle → Black, PlotRange → {{0, 26}, {0, 183.3}}];
```

[estilo do gráfico](#) [preto](#) [intervalo do gráfico](#)

```
Vstars = Plot[Sqrt[Vd[r, M]] /. M → 45.56, {r, 0, 24.83},
```

[gráfico](#) [raiz quadrada](#)

```
PlotStyle → {Black, Dotted}];
```

[estilo do gráfico](#) [preto](#) [linha pontilhada](#)

```
Vhalo = Plot[Sqrt[Vme[r, R, P]] /. {R → 28.48, P → 0.43},
```

[gráfico](#) [raiz quadrada](#)

```
{r, 0, 26}, PlotStyle → {Black, DotDashed}];
```

[estilo do gráfico](#) [preto](#) [ponto e traço](#)

```
Gas = Plot[Igas[x], {x, 0.27931, 24.8276}, PlotStyle → {Black, Dashed},
```

[gráfico](#)

[estilo do gráfico](#) [preto](#) [tracejado](#)

```
AxesLabel → {"R(Kpc)", "V(Km/s)"}];
```

[legenda dos eixos](#)

```
VRC = ErrorListPlot[Table[{RC[[i]], ErrorBar[Erro[[i]]]}, {i, 26}]],
```

[tabela](#)

```
PlotStyle → Black, MeshStyle → PointSize[Large]];
```

[estilo do gráfico](#) [preto](#) [estilo de malha](#) [tamanho do...](#) [grande](#)

```
RCurve = Plot[Vt[r, M, R, P] /. {M → 45.56, R → 28.48, P → 0.43},
```

[gráfico](#)

```
{r, 0, 24.8}, PlotStyle → Black, PlotRange → {{0, 26}, {0, 200}}];
```

[estilo do gráfico](#) [preto](#) [intervalo do gráfico](#)

```
Show[RCurve, VRC, Vstars, Vhalo, Gas, Frame → True, PlotRange → {{0, 26}, {0, 200}},
```

[mostra](#)

[quadro](#)

[verda...](#)

[intervalo do gráfico](#)

```
PlotLabel → "ESO 287-G13", FrameLabel → {"R(Kpc)", "V(Km/s)"}]
```

[etiqueta de gráfico](#)

[legenda do quadro](#)

```
ErrorListPlot[
```

```
{Table[{Table[{data[[i, 1]], Ajuste["FitResiduals"][[i]]}, {i, 26}][[i]],
```

[tabela](#)

[tabela](#)

```
ErrorBar[Erro[[i]]]}, {i, 26}]], PlotStyle → Black,
```

[estilo do gráfico](#) [preto](#)

```
MeshStyle → PointSize[Large], PlotRange → {{0, 26}, {-30, 20}},
```

[tamanho do...](#) [grande](#)

[intervalo do gráfico](#)

```
Frame → True, AspectRatio → 0.2]
```

[quadro](#)

[verda...](#)

[quociente de aspecto](#)

