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## pre-work

在之前的探究中，发现在低动量下的 $TT$ 和 $TTT$ 效应数量级在1~10时， $TS$ 等数量级在 $10^{-16}$ 以下，

因此简化和提升效率(Fortran 程序中计算Fqc矩阵耗时巨大)，只考虑 $TT$ 和 $TTT$ 。

参考第一篇文献和Fortran程序，pion,proton,phi,xi,omega的 $TT$ 或 $TTT$ 均显示给出，利用MMA的Integrate函数得到了

kaon\_TT和lambda0\_TTT积分的解析结果，并转换为Fortran格式代回进行了检验，结果可见“积分替换”文件夹。

为了得到.yaml文件中的数据，使用了数个Python单元插入本程序。

利用NonlinearModelFit函数直接拟合得到cT,cS的值

本文数据有三个来源(data file里有原文件)，对于不同来源数据采用多种办法转为可用数据

粒子种类	数据来源
proton,pbar,pi+,pi-,ka+,ka-	
phi,omega	
lambda,lambdabar,xi,xibar	

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## Initialization

初始化单元, $TT$ 和 $TTT$ 函数定义都封装在ThermalSymbol程序包内

注意事项:

- 1.每次使用前需要输入 $\sqrt{S_{nn}}$  (TeV)和<Npart>
- 2.ThermalSymbol程序包自动调用BaryonCoesSymbol和MesonCoesSymbol，请勿随意改动文件夹结构
- 3.文件夹内另一个main.use1\_TIMES2Pi将实验数据乘上了 $2\pi$ ，似乎是错误的做法

```
In[ ]:= SetDirectory[NotebookDirectory[]];
```

| 设置目录 | 当前笔记本的目录

```
<< "ThermalSymbol`"
```

```
 $\sqrt{S_{nn}}=0.039\text{TeV}$       Npart=341.7
```

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## Import data & fit part1: single particle

本节将每个粒子的实验数据单独考虑，拟合得到cT,cS

结果基本都与实验数据吻合

### functions definition

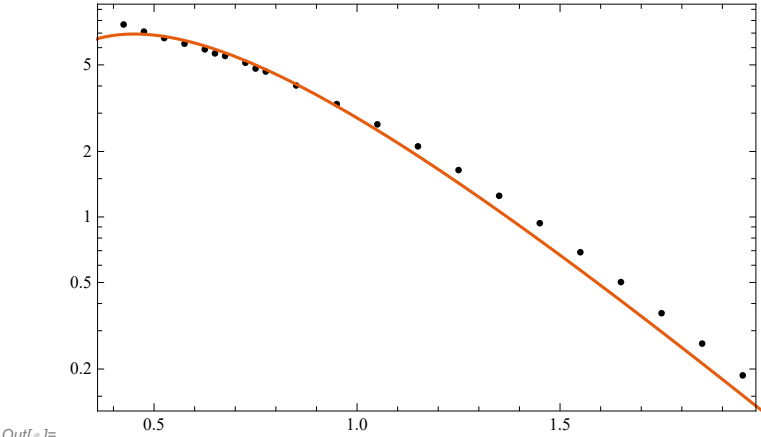
### import data&fit

### proton & pbar

拟合结果给出的cT值大于考虑共振态的pi+,p1-给出的cT值  
将proton数据得到的cT=37.2739应用到接下来的拟合来  
proton∈Proton

FittedModel [  $\frac{217.054 e^{-4.01671 p_t p_t^2}}{\sqrt{0.879844 + p_t^2}}$  ]

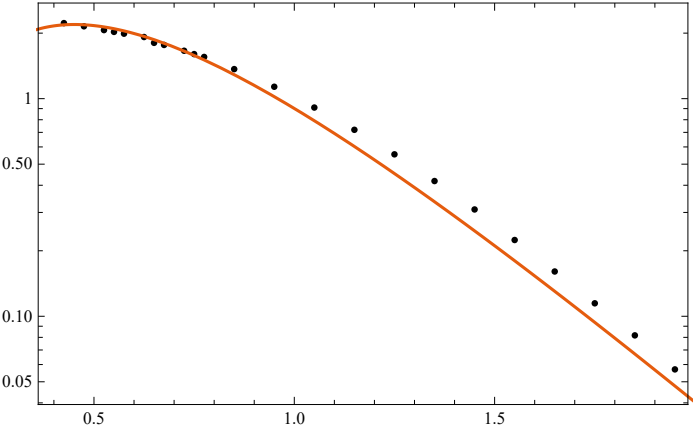
	Estimate	Standard Error	t-Statistic	P-Value
cT	37.2739	0.145251	256.617	$1.17309 \times 10^{-36}$
cS	1.	0.	$\infty$	$0. \times 10^{-324}$
	Estimate	Standard Error	Confidence Interval	
cT	37.2739	0.145251	{36.971, 37.5769}	
cS	1.	0.	{1., 1.}	



pbar∈Proton

FittedModel [  $\frac{68.6216 e^{-4.01671 p_t p_t^2}}{\sqrt{0.879844 + p_t^2}}$  ]

	Estimate	Standard Error	t-Statistic	P-Value
cT	25.3924	0.0851268	298.289	$1.41435 \times 10^{-39}$
cS	1.	0.	$\infty$	$0. \times 10^{-324}$
	Estimate	Standard Error	Confidence Interval	
cT	25.3924	0.0851268	{25.2153, 25.5694}	
cS	1.	0.	{1., 1.}	



pi+ & pi-

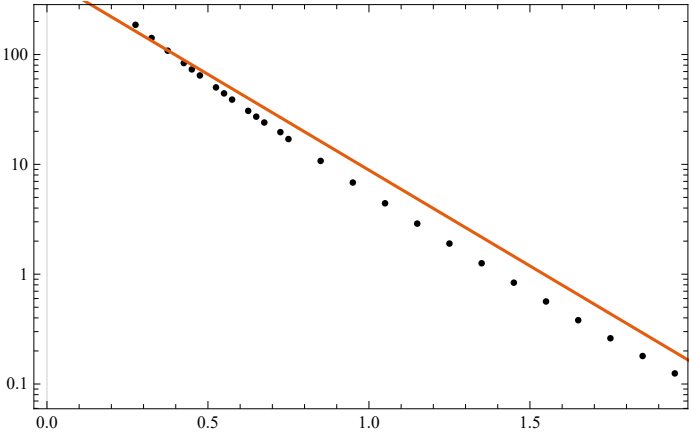
左列不考虑共振态，右列考虑共振态

pi+∈Pion



FittedModel [ 492.092 e<sup>-4.01671 pt</sup> ]

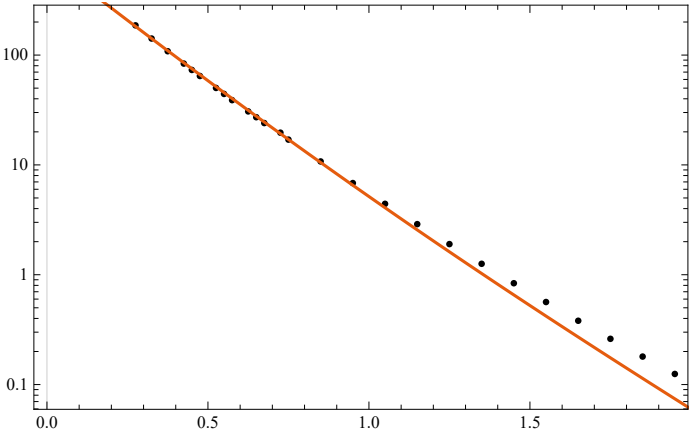
	Estimate	Standard Error	t-Statistic	P-Value
cT	54.3374	0.704584	77.1198	2.8687 × 10 <sup>-30</sup>
cS	1.	0.	∞	0. × 10 <sup>-324</sup>
	Estimate	Standard Error	Confidence Interval	
cT	54.3374	0.704584	{52.8832, 55.7916}	
cS	1.	0.	{1., 1.}	



pi+∈Pion

FittedModel [ 157.096 e<sup>-4.01671 pt</sup> (1. + 3.8251 e<sup>-1.53846 pt</sup>) ]

	Estimate	Standard Error	t-Statistic	P-Value
cT	30.7014	0.0600092	511.612	5.68616 × 10 <sup>-50</sup>
cS	1.	0.	∞	0. × 10 <sup>-324</sup>
	Estimate	Standard Error	Confidence Interval	
cT	30.7014	0.0600092	{30.5775, 30.8252}	
cS	1.	0.	{1., 1.}	

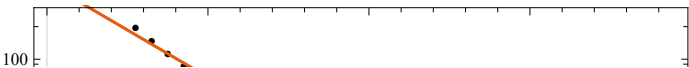


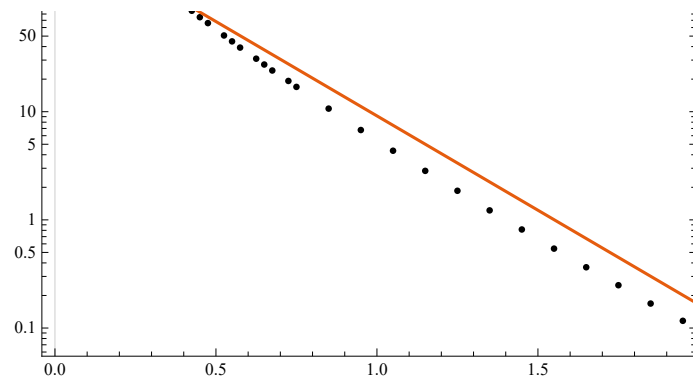
Out[ ]=

pi-∈Pion

FittedModel [ 507.824 e<sup>-4.01671 pt</sup> ]

	Estimate	Standard Error	t-Statistic	P-Value
cT	55.1991	0.783319	70.4682	2.47655 × 10 <sup>-29</sup>
cS	1.	0.	∞	0. × 10 <sup>-324</sup>
	Estimate	Standard Error	Confidence Interval	
cT	55.1991	0.783319	{53.5824, 56.8158}	
cS	1.	0.	{1., 1.}	

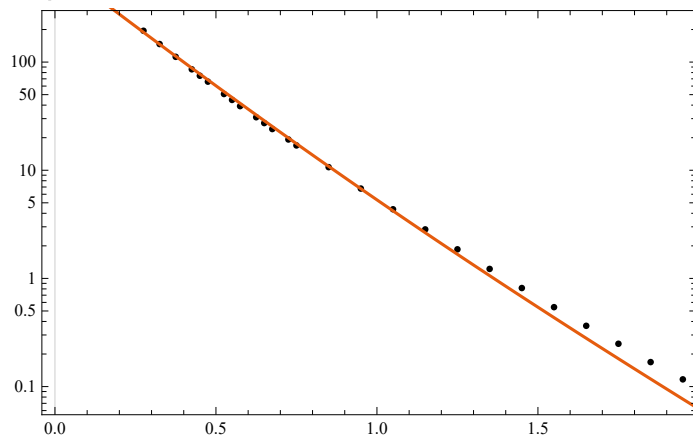




$\pi^- \in \text{Pion}$

FittedModel [  $162.331 e^{-4.01671 \text{ pt}} (1. + 3.8251 e^{-1.53846 \text{ pt}})$  ]

	Estimate	Standard Error	t-Statistic	P-Value
cT	31.2087	0.0945205	330.179	$2.0833 \times 10^{-45}$
cS	1.	0.	$\infty$	$0. \times 10^{-324}$
	Estimate	Standard Error	Confidence Interval	
cT	31.2087	0.0945205	{31.0136, 31.4038}	
cS	1.	0.	{1., 1.}	



## ka+ & ka-

左列是不设定cT值时mathematica给出的最优估计

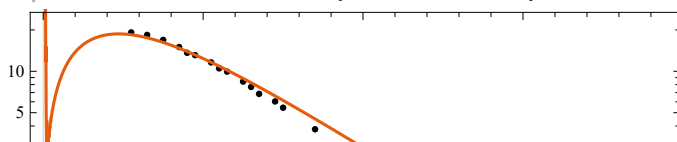
右列是代入cT=37.2739值给出的最优估计

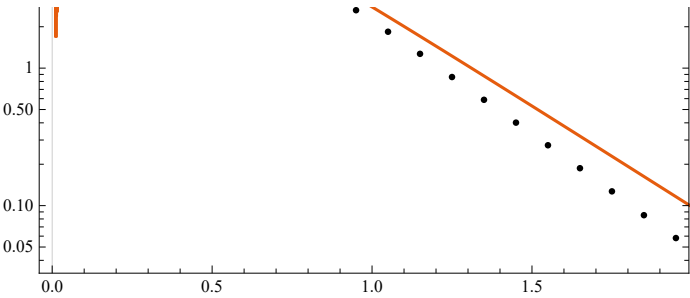
拟合结果存在一定误差

$ka^+ \in \text{Kaon}$

FittedModel [  $\frac{2.77834 \times 10^7 e^{-7.0729 \text{ pt}} (<<1>>)}{\text{pt}^5 \sqrt{0.244036 + \text{pt}^2}}$  ]

	Estimate	Standard Error	t-Statistic	P-Value
cT	27.8809	0.0847275	329.065	$2.2593 \times 10^{-45}$
cS	17.6257	0.134024	131.511	$8.08673 \times 10^{-36}$
	Estimate	Standard Error	Confidence Interval	
cT	27.8809	0.0847275	{27.706, 28.0557}	
cS	17.6257	0.134024	{17.3491, 17.9023}	



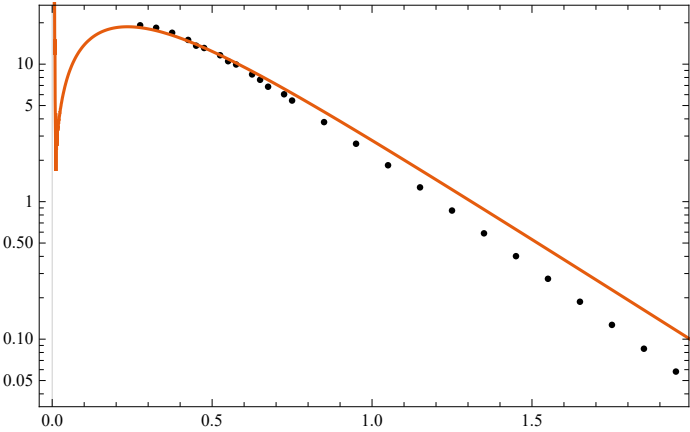


ka+ → eKaon

FittedModel [ 
$$\frac{2.77834 \times 10^7 e^{-7.0729 pt} \ll 1 \gg}{pt^5 \sqrt{0.244036 + pt^2}}$$
 ]

	Estimate	Standard Error	t-Statistic	P-Value
cS	13.184	0.13748	95.8976	$1.29864 \times 10^{-33}$

	Estimate	Standard Error	Confidence Interval
cS	13.184	0.13748	{12.9009, 13.4672}



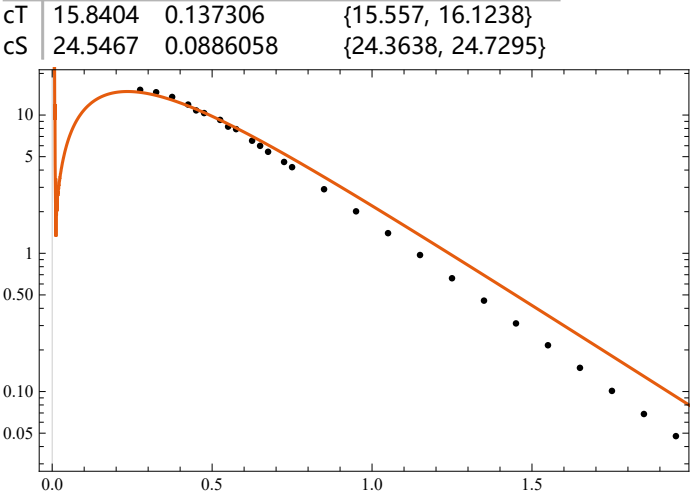
Out[ ]:=

ka- → eKaon

FittedModel [ 
$$\frac{2.19832 \times 10^7 \ll 1 \gg (0.244383 e^{-\ll 1 \gg} (0.132718 + \ll 21 \gg pt + 0.00612222 pt^2) - \ll 1 \gg \ll 1 \gg)}{pt^5 \sqrt{0.244036 + pt^2}}$$
 ]

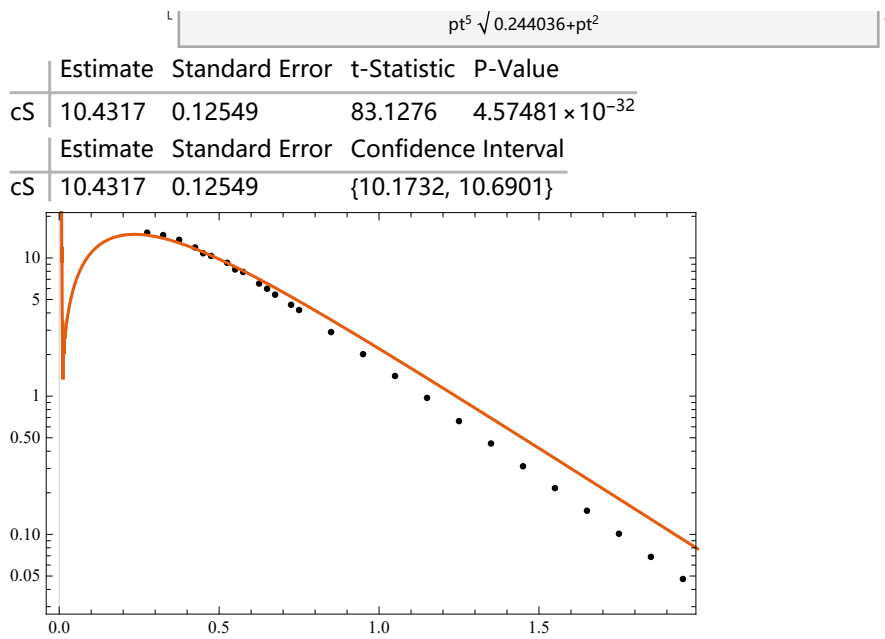
	Estimate	Standard Error	t-Statistic	P-Value
cT	15.8404	0.137306	115.366	$1.86622 \times 10^{-34}$
cS	24.5467	0.0886058	277.032	$1.40461 \times 10^{-43}$

	Estimate	Standard Error	Confidence Interval
cT	15.8404	0.137306	{15.557, 16.1238}
cS	24.5467	0.0886058	{24.3638, 24.7295}



ka- → eKaon

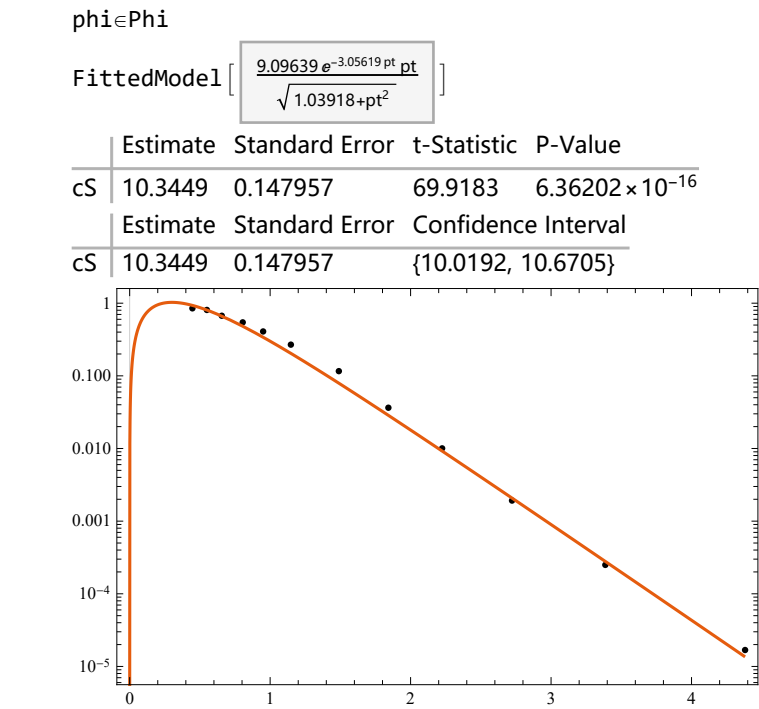
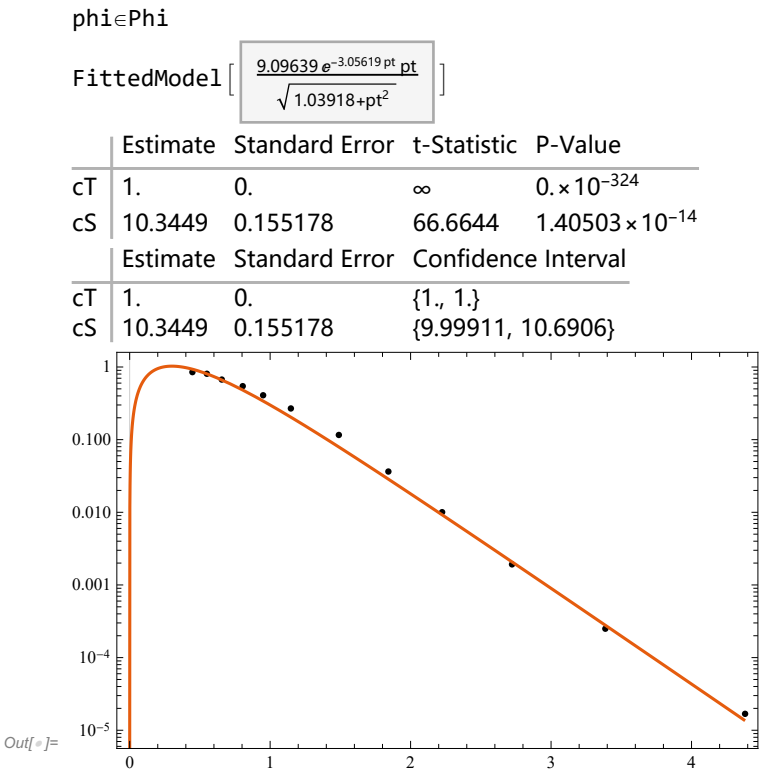
FittedModel [ 
$$\frac{2.19832 \times 10^7 \ll 1 \gg (0.244383 e^{-\ll 1 \gg} (0.132718 + \ll 21 \gg pt + 0.00612222 pt^2) - \ll 1 \gg \ll 1 \gg)}{pt^5 \sqrt{0.244036 + pt^2}}$$
 ]



phi & omega different centrality 0~10%

phi

$\mathcal{T}(\phi)$ 中不含cT,故是否给cT赋值结果均相等



omega

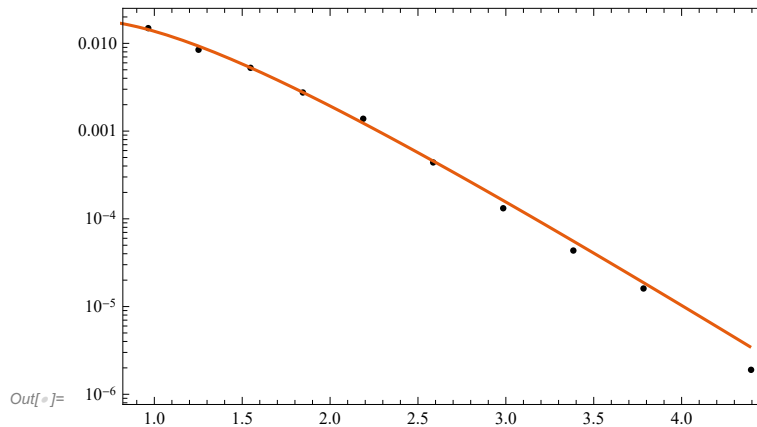
$\mathcal{T}\mathcal{T}\mathcal{T}(\Omega)$ 中不含cT,故是否给cT赋值结果均相等

$\omega \in \Omega$

$$\text{FittedModel} \left[ \frac{0.568735 e^{-3.05619 \text{pt}} \text{pt}^2}{\sqrt{2.79558 + \text{pt}^2}} \right]$$

	Estimate	Standard Error	t-Statistic	P-Value
cT	1.	0.	$\infty$	$0. \times 10^{-324}$
cS	11.537	0.0765104	150.789	$4.18504 \times 10^{-15}$

	Estimate	Standard Error	Confidence Interval
cT	1.	0.	{1., 1.}
cS	11.537	0.0765104	{11.3605, 11.7134}

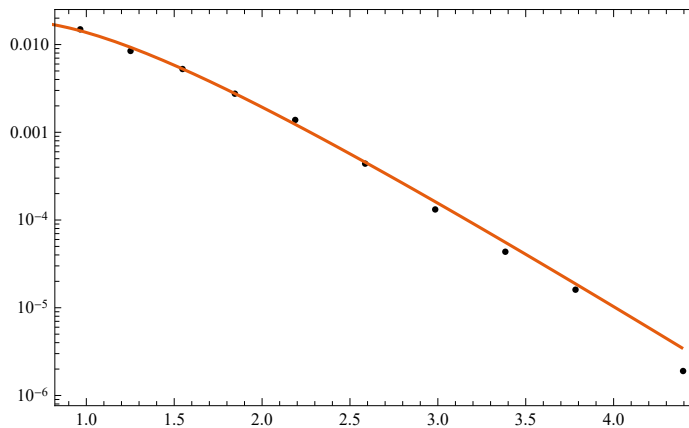


$\omega \in \Omega$

$$\text{FittedModel} \left[ \frac{0.568735 e^{-3.05619 \text{pt}} \text{pt}^2}{\sqrt{2.79558 + \text{pt}^2}} \right]$$

	Estimate	Standard Error	t-Statistic	P-Value
cS	11.537	0.0721347	159.936	$7.4254 \times 10^{-17}$

	Estimate	Standard Error	Confidence Interval
cS	11.537	0.0721347	{11.3738, 11.7001}



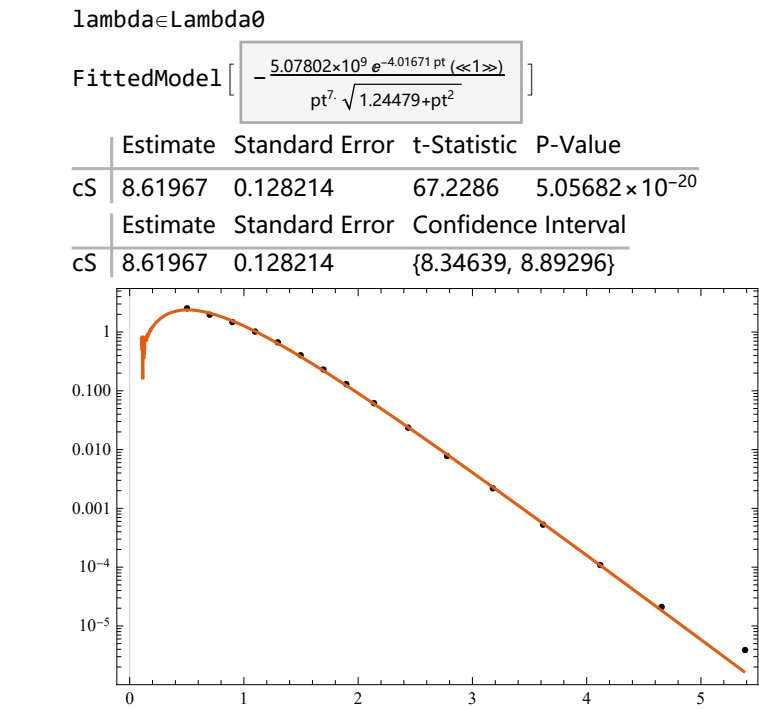
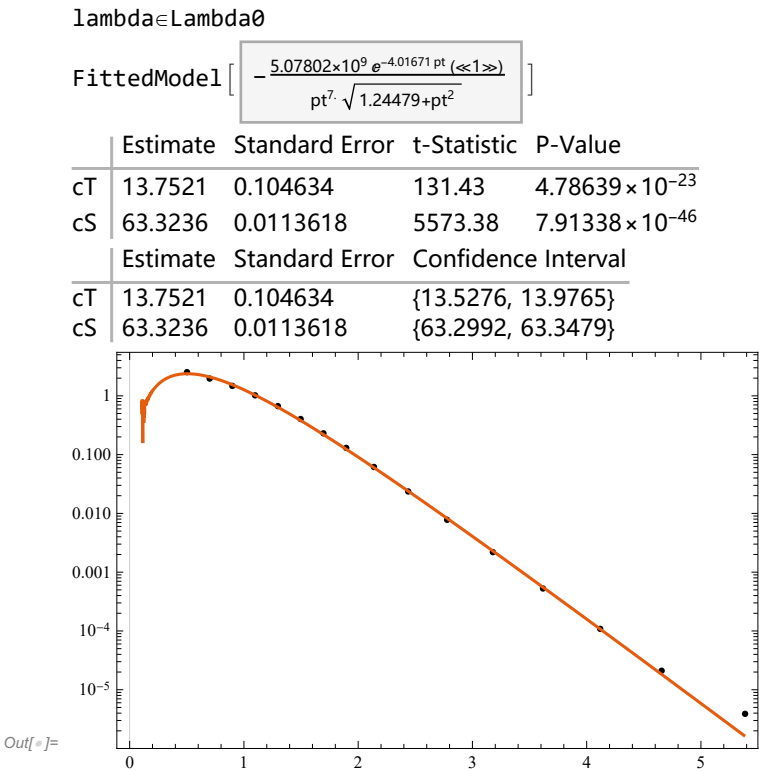
import data with python

functions definition

lambda


In[ ]:=  INfunc(r"C:\Users\86153\Desktop\fig6\_lambda\_auau39\_cent6.yaml")





lambdabar

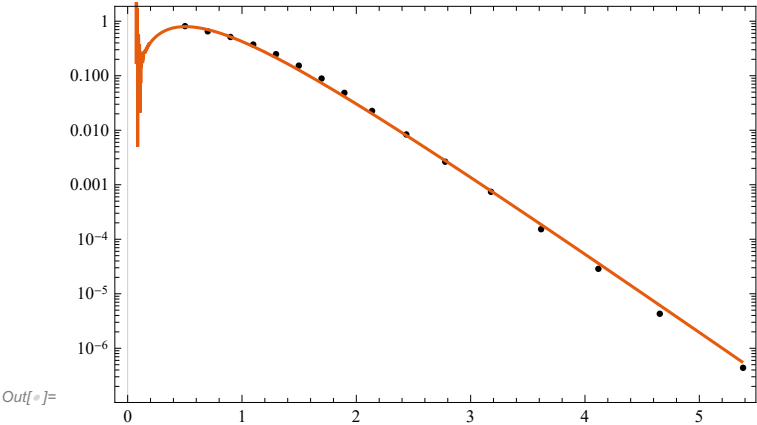
In[ ]:=

 INfunc(r"C:\Users\86153\Desktop\Thermal\_0.1\data  
file\fig7\_lambdabar\_auau39\_cent6.yaml")

lambdabar∈Lambda0

FittedModel [ 
$$-\frac{1.6979 \times 10^9 e^{-4.01671 \text{ pt}} (\ll 1 \gg)}{\text{pt}^7 \sqrt{1.24479 + \text{pt}^2}}$$
 ]

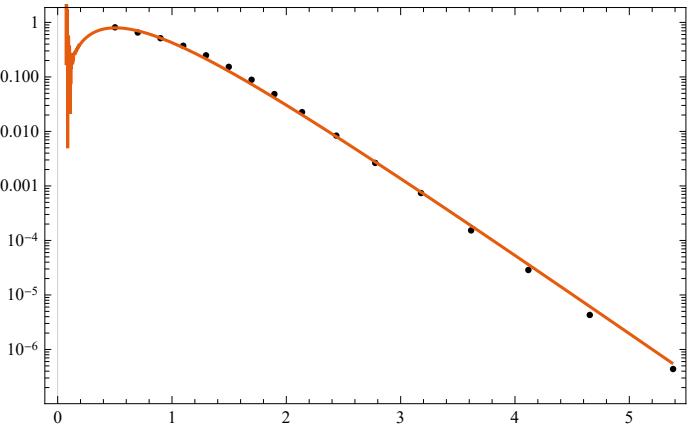
	Estimate	Standard Error	t-Statistic	P-Value
cT	10.8616	0.0845448	128.471	$6.5815 \times 10^{-23}$
cS	33.9417	0.0135274	2509.1	$5.63344 \times 10^{-41}$
	Estimate	Standard Error	Confidence Interval	
cT	10.8616	0.0845448	{10.6802, 11.0429}	
cS	33.9417	0.0135274	{33.9127, 33.9707}	




lambdabar∈Lambda0

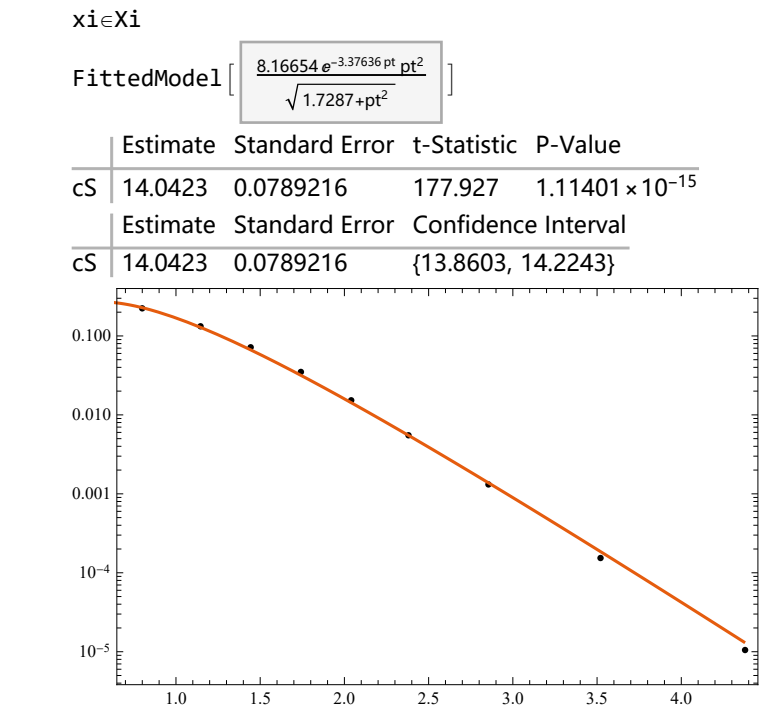
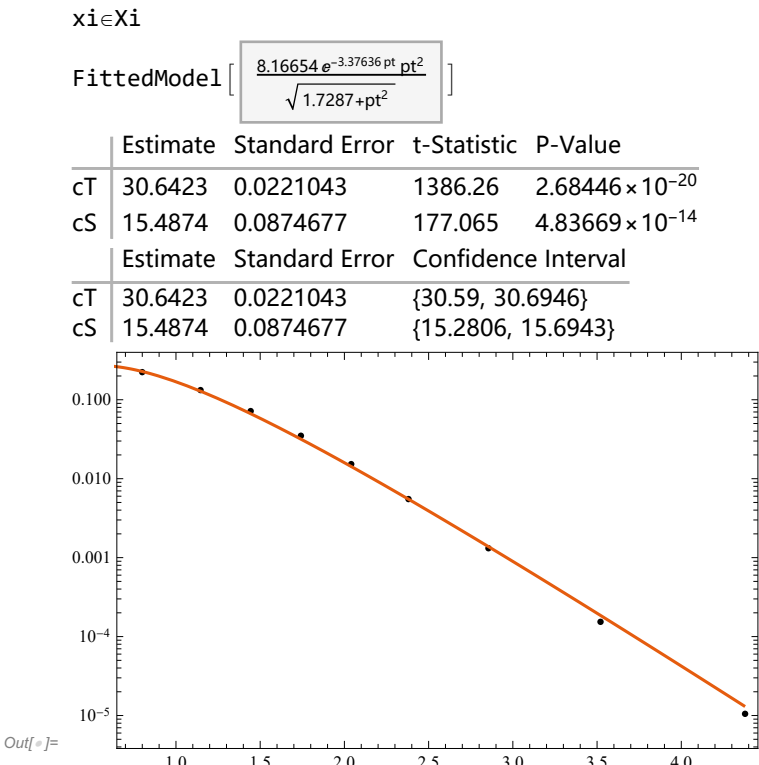
FittedModel [ 
$$-\frac{1.6979 \times 10^9 e^{-4.01671 \text{ pt}} (\ll 1 \gg)}{\text{pt}^7 \sqrt{1.24479 + \text{pt}^2}}$$
 ]

	Estimate	Standard Error	t-Statistic	P-Value
cS	2.8821	0.0444559	64.8304	$8.70444 \times 10^{-20}$
	Estimate	Standard Error	Confidence Interval	
cS	2.8821	0.0444559	{2.78734, 2.97685}	




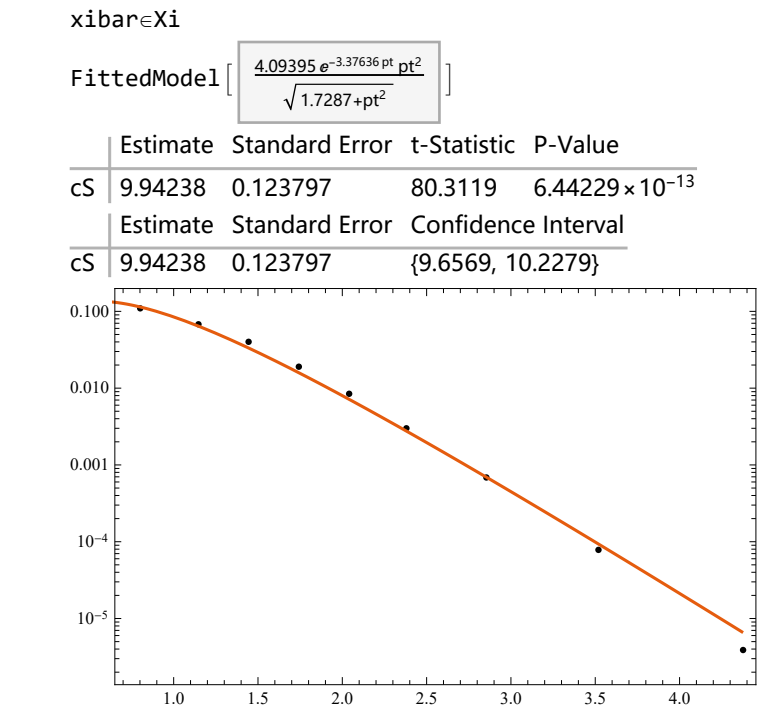
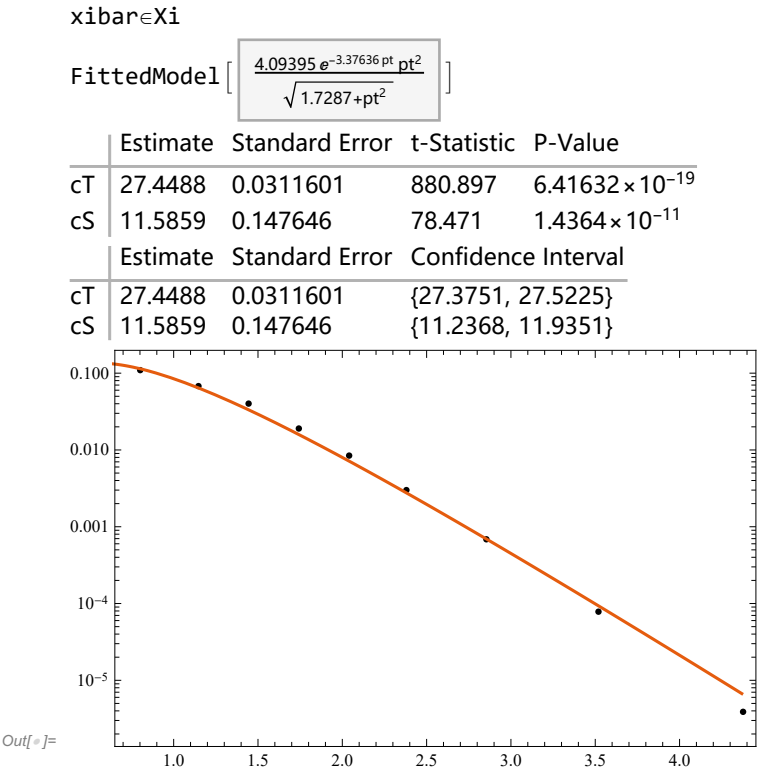
xi

In[\*]:=  INfunc(r"C:\Users\86153\Desktop\Thermal\_0.1\data file\fig8\_xi\_auiu39\_cent6.yam1")



xibar

```
In[ ]:=  INfunc(r"C:\Users\86153\Desktop\Thermal_0.1\data file\fig9_xibar_auiu39_cent6.yaml")
```



# Quit

这部分是为了调试程序

In[ ]:= (\*Quit\*)  
|退出内核