

Reunião do Grupo de Raios Cósmicos – PDPD

- Introdução à Física de Astropartículas
- Introdução aos Projetos de PDPD
- Instalação do Dropbox
- Instalação do Anaconda (Python)
- Aula 1 de Astropartículas
- Instalação Dev-C++
- Instalação do ROOT

Prof. Marcelo Leigui
26/5/26



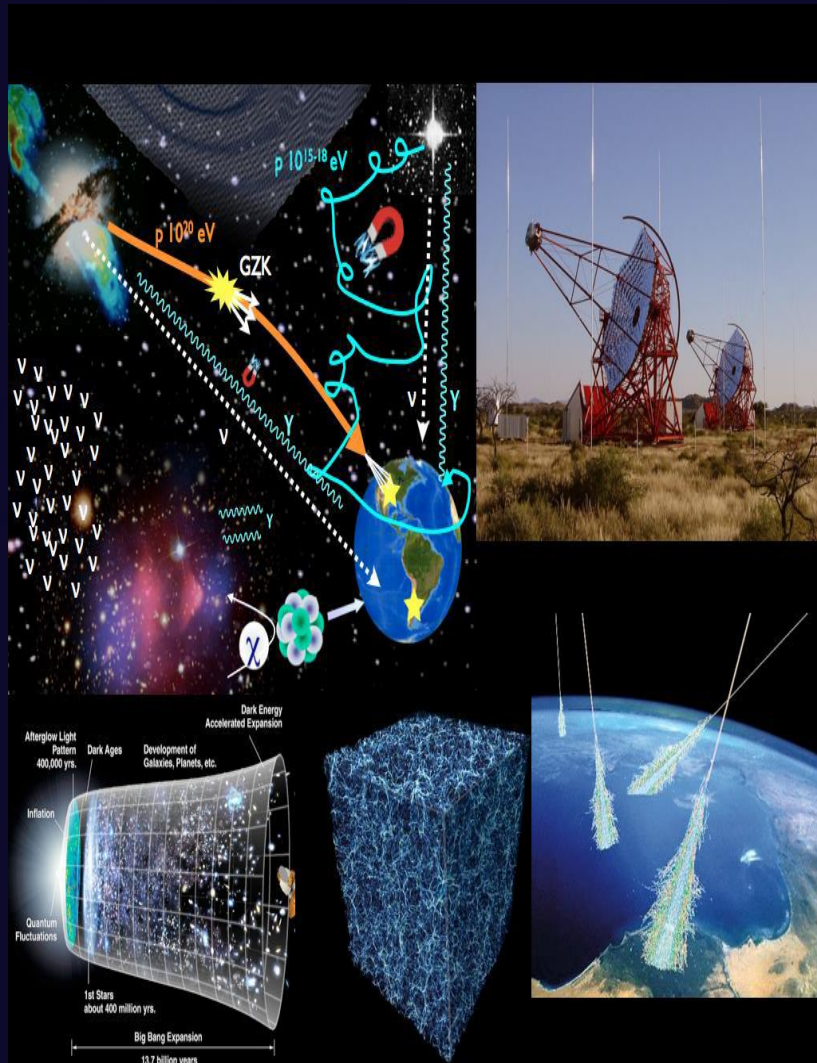
Introdução à Física de Astropartículas

A Física de Astropartículas é uma disciplina fascinante que estuda as partículas de alta energia que permeiam o Universo. Essa área interdisciplinar combina conhecimentos de física de partículas, astrofísica e cosmologia, oferecendo uma visão única sobre a estrutura fundamental da matéria e a evolução do cosmos.



by Prof. Marcelo Leigui
<http://professor.ufabc.edu.br/~leigui>
leigui@ufabc.edu.br
[@marceloleigui](https://twitter.com/marceloleigui)

O que é a Física de Astropartículas?



Estudo de Partículas Cósicas

A Física de Astropartículas se concentra no estudo das partículas de alta energia que vêm do espaço, como os raios cósmicos.

Fenômenos Astronômicos

Essa área também investiga os processos astronômicos que geram e emitem essas partículas, como explosões de estrelas, buracos negros e galáxias ativas.

Conexão com a Cosmologia

A Física de Astropartículas ajuda a desvendar os mistérios da matéria e energia escuras, que são fundamentais para a compreensão da evolução do Universo.

Novas Descobertas

Essa ciência interdisciplinar tem o potencial de revelar novos insights sobre a física fundamental e a estrutura do cosmos.

Partículas de alta energia do Universo

1

Raios Cósmicos

Fluxos de partículas de alta energia que chegam à Terra, incluindo prótons, elétrons e núcleos atômicos.

2

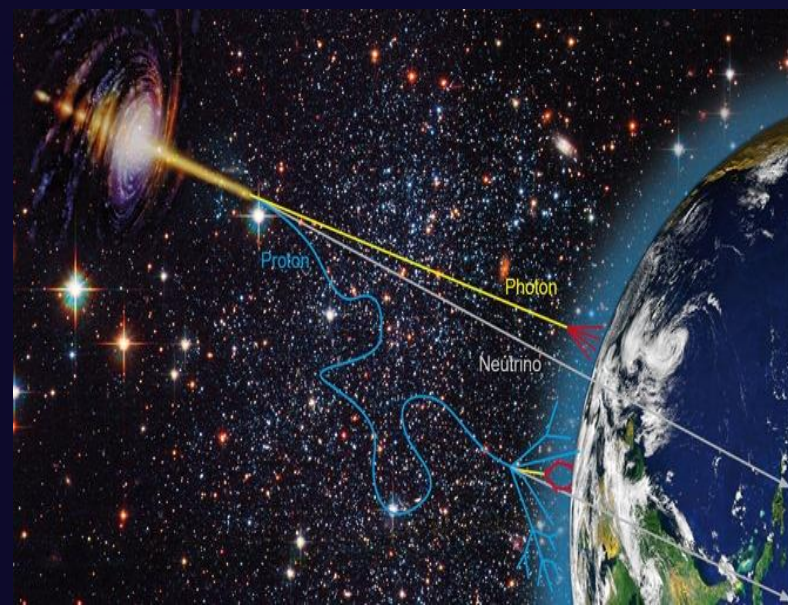
Neutrinos Cósmicos

Partículas neutras e de massa muito pequena, que atravessam a matéria com facilidade e fornecem informações sobre eventos cósmicos.

3

Radiação Gama Cósmica

Fótons de altíssima energia emitidos por fenômenos astronômicos violentos, como explosões de raios gama.



Raios cósmicos e sua origem

Origens Astrofísicas

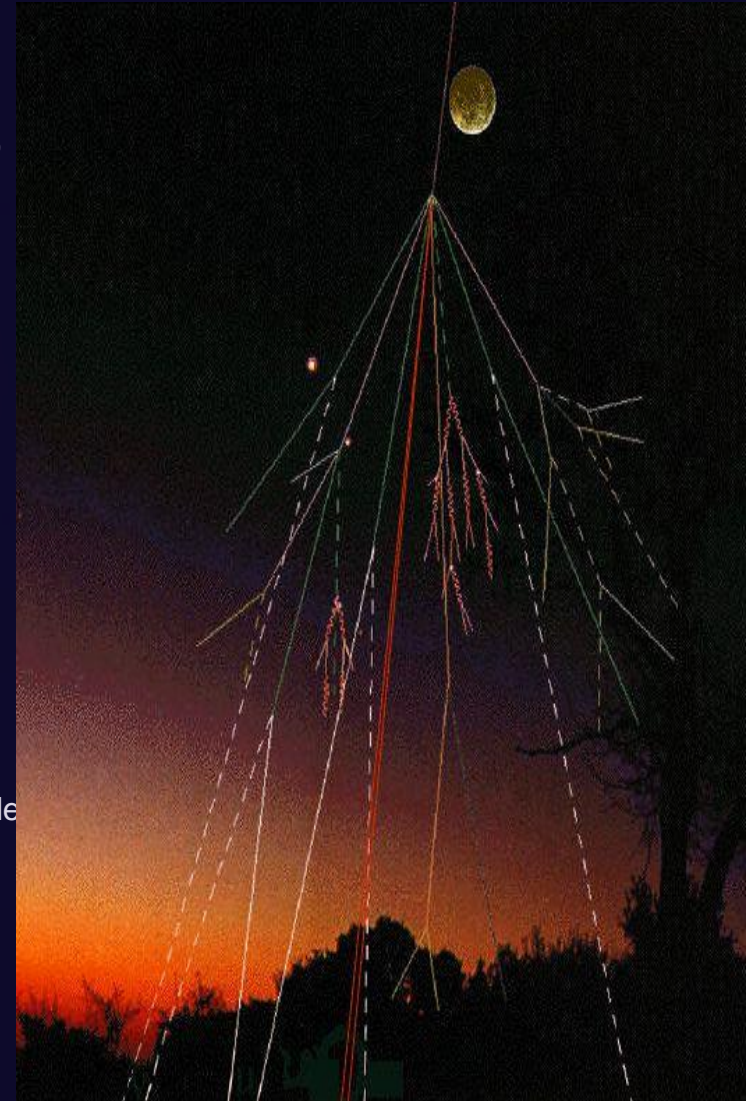
Os raios cósmicos são produzidos por eventos violentos no Universo, como explosões de supernovas, jatos de buracos negros e regiões de intensa atividade estelar.

Aceleração a Altas Energias

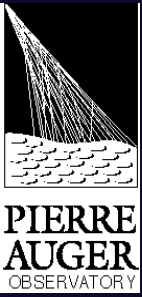
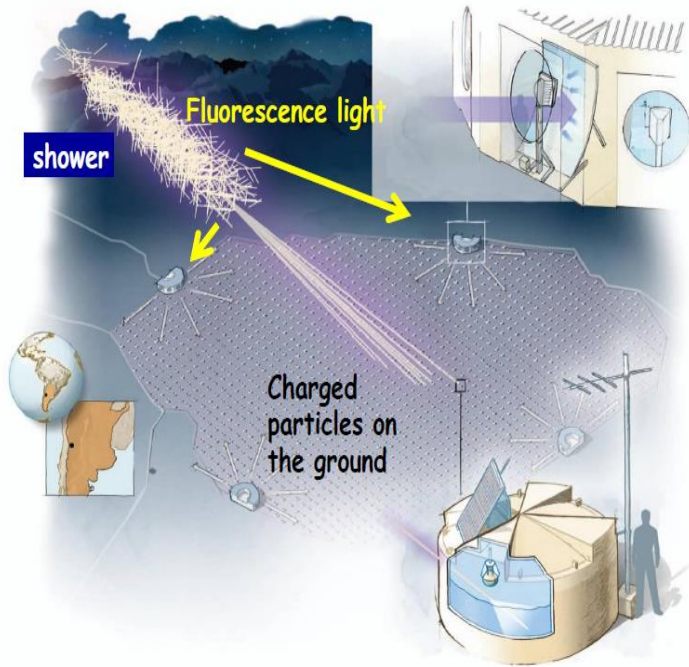
Campos magnéticos e ondas de choque nesses ambientes cósmicos são capazes de acelerar partículas a velocidades próximas à da luz.

Impacto na Terra

Ao chegarem na Terra, os raios cósmicos interagem com a atmosfera e podem produzir chuviros de partículas secundárias.

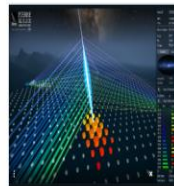


Pierre Auger Observatory layout



Home / Science / Publications / Scientific Highlights

Scientific Highlights

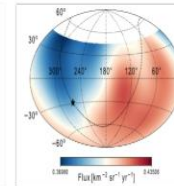


The Pierre Auger Observatory Open Data

Get more...

The challenge of making cosmic-ray data open and DAtR

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Update on the large-angular-scale studies at the Pierre Auger Observatory with 19 years of data

The Pierre Auger Collaboration has published an update on large-angular-scale analyses using data from Phase 1 of the Auger Observatory.

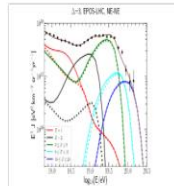
Read more...



AI-powered algorithm sheds new light on the mass composition of cosmic rays at ultra-high energies

Researchers are paving the way for a deeper understanding of the origins of UHCR.

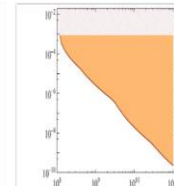
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On the hardness of the CR high-energy injection spectra

The impact of the magnetic horizon on the interpretation of the spectrum and composition data

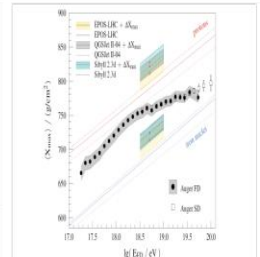
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Constraints on metastable superheavy dark matter coupled to sterile neutrinos

One intriguing aspect of the Standard Model (SM) of particle physics is the absence of right-handed degrees of freedom to describe neutrinos...

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Beyond the 'Muon Puzzle'

Testing hadronic interaction models using hybrid data of the Pierre Auger Observatory

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May 22, 2025

The LST Collaboration Finalises Mirror Installation on LST-3



May 20, 2025

CTAO Consortium Spring 2025 Meeting: A Week of Scientific Synergies and News



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The CTAO Launches the Werner Hofmann Scientific Award

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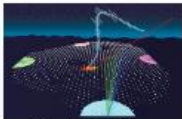
Laboratório de Astropartículas:

L 1101, 11º andar, Bloco B
Campus de Santo André - UFABC.
F: (11) 4996-0095

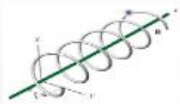


Arquivos: 📁

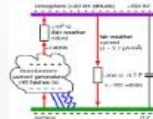
Projetos:



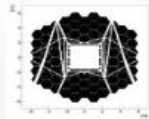
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[Circuito elétrico global](#)



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Index of /~leigui/pesquisa/arquivos

<u>Name</u>	<u>Last modified</u>	<u>Size</u>	<u>Description</u>
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 Apresentacao1.pptx	2025-08-21 12:42	5.0M	
 AulasFisicaAstrop.pdf	2025-08-21 11:00	2.9M	
 AulasROOT/	2025-08-21 11:23	-	
 CircEletrGlobal.pdf	2020-04-30 16:00	395K	
 ComposiRCs.pdf	2020-05-13 17:15	531K	
 Historia Astropartic.>	2024-10-27 12:14	4.1M	
 IC_2017_CTA.pdf	2017-05-17 17:58	352K	
 Introduction-to-Astr.>	2025-06-02 12:07	1.3M	
 PDPD_Auger.pdf	2019-07-12 12:19	310K	
 Projeto IC DistorÃ.>	2025-08-07 12:50	532K	
 Projeto PDPD Rastrea.>	2025-08-07 11:27	221K	
 Projeto PDPD A for.>	2025-08-10 21:05	115K	
 Projeto PDPD Disto.>	2025-08-10 11:23	587K	
 Projeto PDPD Estud.>	2025-08-07 12:50	346K	
 Projeto PDPD Impac.>	2025-08-10 19:17	597K	
 Projeto PDPD Medid.>	2025-08-06 18:25	695K	
 Projeto PDPD Simu.>	2025-08-21 12:28	209K	
 PropagRCs.pdf	2020-05-14 13:31	248K	
 RCs e a origem da vi.>	2025-08-20 22:21	109M	
 progs/	2025-08-21 10:43	-	

Dropbox

The screenshot shows the Dropbox web interface in a browser window. The browser's address bar displays 'dropbox.com/home'. A blue notification banner at the top states: 'Seu espaço está quase no fim! Faça upgrade para obter 2 TB (2.000 GB) ou mais de espaço e poder compartilhar seu conteúdo com segurança. Compare os planos'. The interface is dark-themed and includes a sidebar on the left with navigation options like 'Início', 'Todos os arquivos', 'Fotos', 'Compartilhado', 'Pastas', 'Arquivos excluídos', 'Ações', and 'Mais'. The main content area is titled 'Todos os arquivos' and features a search bar, a '+ Novo' button, and a 'Convidar membros' button. Below this, there are 'Sugerido para você' cards for folders like 'CosmicRays', 'finanças', 'apres', and 'ged'. A table lists files and folders with columns for 'Nome', 'Última modificação', 'Tamanho', and 'Acesso'. A system tray notification for 'Dropbox 252.4.3485 Atualizado' is visible in the bottom right corner.

Seu espaço está quase no fim! Faça upgrade para obter 2 TB (2.000 GB) ou mais de espaço e poder compartilhar seu conteúdo com segurança. [Compare os planos](#)

Início

+ Novo

Convidar membros [Clique aqui para fazer upgrade](#)

Enviar Nova pasta Abrir aplicativo Somente você

Todos os arquivos

Sugerido para você

- CosmicRays Pasta • bib
- finanças Pasta • Dropbox
- apres Pasta • Work
- ged Pasta • Solar

Recentes Favoritos

Nome ↑	Última modificação	Tamanho	Acesso
Camera Uploads	--	--	Somente você
Capturas de tela	--	> 7,16 MB	Somente você
finanças	--	> 2,43 MB	Somente você
home	--	> 4,68 MB	Somente você
Public	--	--	Somente você
solar	--	> 8,12 MB	Somente você

Enviar qualquer coisa 17,6 GB de 20,25 GB

Faça upgrade para obter mais

Dropbox 252.4.3485 Atualizado

Pesquisar 24°C Ensolarado 15:58 26/05/2025

Dropbox

The screenshot shows the Dropbox web interface in a browser. The main content area displays a list of folders under 'Todos os arquivos'. A red arrow points to the 'Abrir aplicativo' button in the top right corner of the interface.

Seu espaço está quase no fim! Faça upgrade para obter 2 TB (2.000 GB) ou mais de espaço e poder compartilhar seu conteúdo com segurança. [Compare os planos](#)

+ Novo [Convidar membros](#) [Clique aqui para fazer upgrade](#)

Enviar Nova pasta Abrir aplicativo

Sugerido para você

- CosmicRays Pasta • bib
- finanças Pasta • Dropbox
- apres Pasta • Work
- ged Pasta • Solar

Recentes Favoritos

Nome ↑	Última modificação	Tamanho	Acesso
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home	--	> 4,68 MB	Somente você
Public	--	--	Somente você
solar	--	> 8,12 MB	Somente você

Enviar qualquer coisa 17,5 GB de 20,25 GB

Faça upgrade para obter mais

Dropbox 252.4.3485 Atualizado

1. Instalar como aplicativo

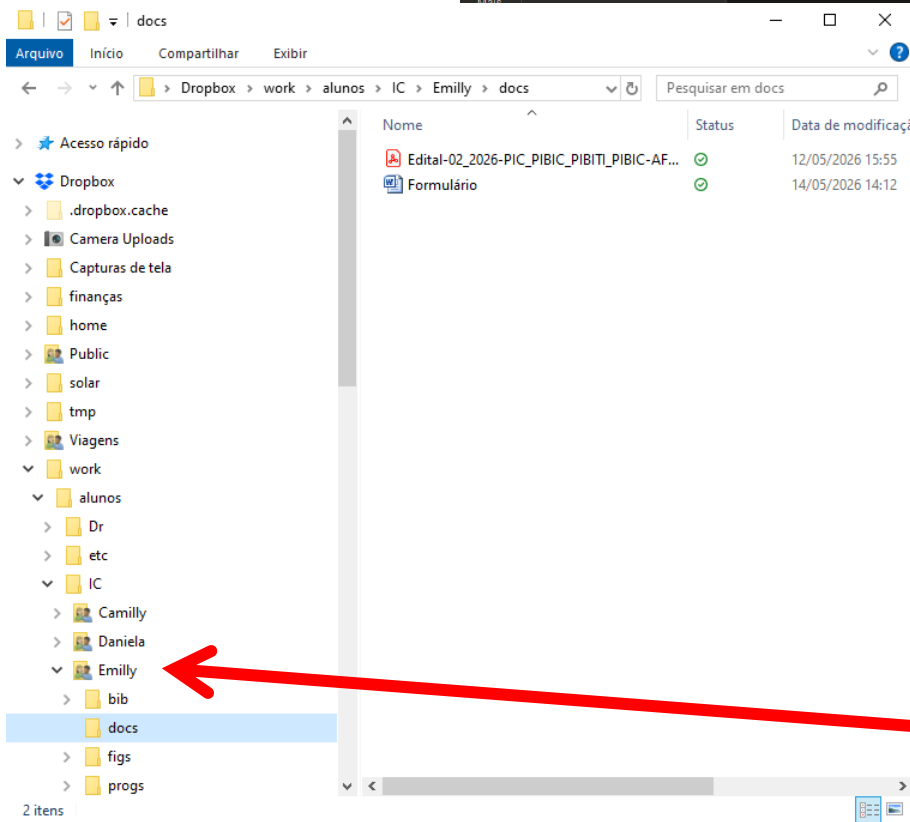
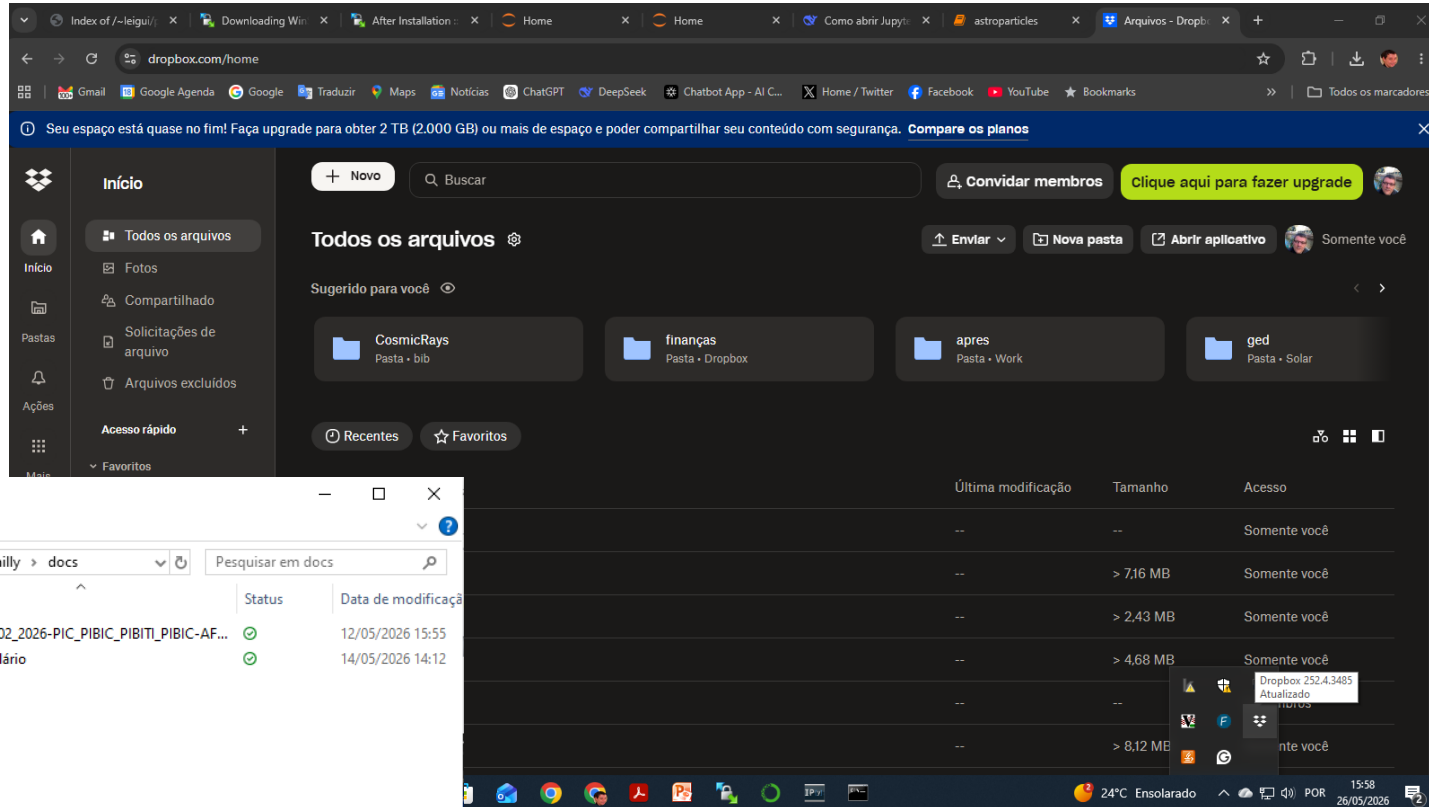
Dropbox

The screenshot shows the Dropbox web interface in a browser window. The address bar displays 'dropbox.com/home'. A notification at the top states: 'Seu espaço está quase no fim! Faça upgrade para obter 2 TB (2.000 GB) ou mais de espaço e poder compartilhar seu conteúdo com segurança. Compare os planos'. The main content area is titled 'Todos os arquivos' and features a search bar, a '+ Novo' button, and a 'Convidar membros' button. Below this, there are several folder thumbnails: 'CosmicRays', 'finanças', 'apres', and 'ged'. A table below lists files and folders with columns for 'Nome', 'Última modificação', 'Tamanho', and 'Acesso'. The table lists folders like 'Camera Uploads', 'Capturas de tela', 'finanças', 'home', 'Public', and 'solar'. A sidebar on the left contains navigation options like 'Início', 'Pastas', and 'Ações'. A Windows taskbar is visible at the bottom with the search bar and various application icons.

Nome	Última modificação	Tamanho	Acesso
Camera Uploads	--	--	Somente você
Capturas de tela	--	> 7,16 MB	Somente você
finanças	--	> 2,43 MB	Somente você
home	--	> 4,68 MB	Somente você
Public	--	--	Somente você
solar	--	> 8,12 MB	Somente você

1. Instalar como aplicativo
2. Enviar o seu e-mail associado

Dropbox



1. Instalar como aplicativo
2. Enviar o seu e-mail associado
3. Vou abrir a sua pasta

Dropbox

Arquivo Início Compartilhar Exibir

Dropbox > work > workGRC > bib > CosmicRays

Nome Status

Nome	Status
2018_Book_IntroductionToParticleAndAstro	✓
2210.05659	✓
Attallah_2021_J._Phys._Conf._Ser._1766_012004	✓
AulasFisicaAstrop	✓
chp%3A10.1007%2F978-3-642-29949-0_2	✓
chp%3A10.1007%2F978-94-007-1658-2_1	✓
Cosmic Ray History (PDFDrive)	✓
Cosmic_Ray_Origin_Lessons_from_Ultra-Hig	✓
CTA_Sensitivity_for_Heavy_Elements_SAPO	✓
de Angelis & Pimenta - Introd 2 Part & Astrop Phys (2015)	✓
From the Universe to Elementary Particles	✓
Grieder - Cosmic Rays at Earth (2001)	✓
Grieder - Extensive Air Showers Vol.1 (2010)	✓
Kuzmichev2021_Article_CosmicRayStudyAtTheAstrophysic	✓
Marcelo Leigui - Física de EAS	✓
Miroshnichenko - Solar Cosmic Rays (2001,1015)	✓
Open_Questions_in_Cosmic-Ray_Research_at_Ultrahigh	✓
Peter_Meszáros-The High Energy Universe (2010)	✓
Spurio - Particles and Astrophysics (2)	✓
Spurio - Particles and Astrophysics (2015)	✓

22 itens | 1 item selecionado | 18,9 MB | Disponível neste dispositivo

ociado

3. Vou abrir a sua pasta
4. Acesso à pasta workGRC

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Filter files by name

/

Name	Modified
3D Objects	10mo ago
anaconda_projects	1m ago
Contacts	10mo ago
Documents	2d ago
Downloads	yesterday
Dropbox	17m ago
Favorites	10mo ago
Links	10mo ago
OneDrive	12m ago
Saved Games	10mo ago
Searches	10mo ago
miktex-console.lo...	10mo ago
Untitled.ipynb	40s ago
Untitled1.ipynb	32s ago
Untitled2.ipynb	13s ago

Untitled1.ipynb

Code

Share Notebook No Kernel

```
[ ]:
```

← → ↻ Inseguro professor.ufabc.edu.br/~leigui/pesquisa/arquivos/progs/Python/

🗄️ | 📧 Entrada (8.967) - ma... 🌐 Google 📅 Google Agenda 🗨️ Traduzir 📍 Maps 📰 Notícias 🗨️ Ho

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<u>Name</u>	<u>Last modified</u>	<u>Size</u>	<u>Description</u>
 Parent Directory		-	
 astroparticles.ipynb	2025-08-21 11:11	182K	

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Launch



anaconda_prompt

1.1.0

Opens a terminal instance with conda activated (requires menuinst 2.1.1 or greater).

Launch



JupyterLab

4.2.5

An extensible environment for interactive and reproducible computing, based on the Jupyter Notebook and Architecture.



Jupyter Notebook

7.2.2

Web-based, interactive computing notebook environment. Edit and run human-readable docs while describing the



IPyT Console

5.5.1

PyQt GUI that supports inline figure proper multiline editing with syntax highlighting, graphical calling, and more.



Spyder

5.5.1

Scientific Python Development Environment. Powerful Python IDE with advanced editing, interactive testing,



EduBlocks

Web-based coding platform from Anaconda designed for students. Learn Python coding through an interactive, AI environment.

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Dicas úteis

1. Como abrir um arquivo `.ipynb` com duplo clique?

Por padrão, não dá. Mas você pode configurar:

1. Abra o Anaconda Prompt

2. Digite os comandos:

```
bash

pip install nbopen
python -m nbopen.install_win
```

Copiar

Baixar

3. Pronto! Agora você pode dar duplo clique em qualquer arquivo `.ipynb`

Filter files by name

/ ... / progs / Python /

Name	Modified
astroparticles.ipynb	14d ago

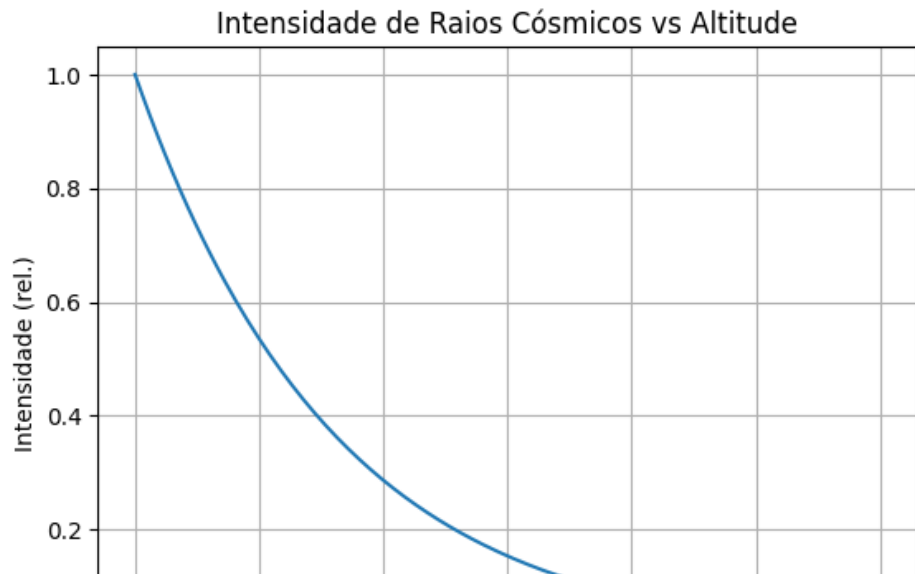
Untitled1.ipynb | astroparticles.ipynb

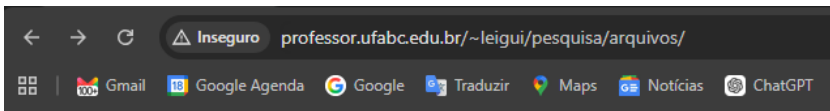
+ - Copy Paste Run Code

```
[1]: %matplotlib inline

import numpy as np
import matplotlib.pyplot as plt

h = np.linspace(0, 30, 200) # altitude em km
I = np.exp(-h / 8)         # atenuação exponencial
plt.plot(h, I)
plt.xlabel('Altitude (km)')
plt.ylabel('Intensidade (rel.)')
plt.title('Intensidade de Raios Cósmicos vs Altitude')
plt.grid(True)
plt.show()
```





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CircEletrGlobal.pdf	2020-04-30 16:00	395K	
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Historia Astropartic.>	2024-10-27 12:14	4.1M	
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Projeto_PDPD_A_for.>	2025-08-10 21:05	115K	
Projeto_PDPD_Disto.>	2025-08-10 11:23	587K	
Projeto_PDPD_Estud.>	2025-08-07 12:50	346K	
Projeto_PDPD_Impac.>	2025-08-10 19:17	597K	
Projeto_PDPD_Meid.>	2025-08-06 18:25	695K	
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RCs e a origem da vi.>	2025-08-20 22:21	109M	
progs/	2025-08-21 10:43	-	

Aula 1: Introdução à Física de Astropartículas

Prof. Dr. Marcelo Augusto Leigui de Oliveira

1. Física de Astropartículas: Uma Ciência Interdisciplinar

A **Física de Astropartículas** é um campo científico moderno e profundamente interdisciplinar. Ela surge da necessidade de compreender fenômenos cósmicos extremos por meio da detecção de partículas subatômicas e radiações altamente energéticas que chegam à Terra vindas do Universo.

Por unir técnicas e conceitos da física de partículas, astrofísica, cosmologia e relatividade geral, esse campo representa uma fronteira natural entre o muito pequeno e o muito grande — entre os constituintes fundamentais da matéria e as estruturas do cosmos.




1.1 Impacto na Astrofísica

Na astrofísica, a física de astropartículas oferece ferramentas para investigar eventos de altíssima energia, como:

- Supernovas, pulsares e buracos negros.
- Galáxias ativas e explosões de raios gama (GRBs).
- Ambientes com campos magnéticos e gravitacionais intensos.

A detecção de partículas cósmicas fornece evidências sobre esses objetos e sobre os mecanismos de aceleração natural de partículas.

Index of /~leigui/pesquisa/arquivos/progs/initC++

Name	Last modified	Size	Description
 Parent Directory		-	
 CRs.tgz	2020-05-19 17:26	125K	
 LEIAME.txt	2024-04-03 14:54	3.7K	

Arquivos para desenvolver um projeto em C++ orientado a objetos.

Esta pasta contem este arquivo (LEIAME.txt) e um arquivo contendo o pacote (CRs.tgz).

O pacote consiste em um programa principal (Main) com tres classes (Atmsphere, Mathematics e Physics), em cada caso, os codigos (*.cc) estao acompanhados dos cabecalhos, ou "headers", (*.h)

```
Main.cc
Main.h
Atmsphere.cc
Atmsphere.h
Atmsphere.dat
Mathematics.cc
Mathematics.h
Physics.cc
Physics.h
```

Rodando em Windows:

- 1- baixe e instale o Dev-C++ IDE em seu computador: <https://sourceforge.net/projects/orwelldevcpp/>
- 2- baixe o tarball CRs.tgz e descompacte-o completamente
- 3- clique 2 vezes em CRs.dev: o Dev-C++ IDE ira carregar os arquivos Main.*, Mathematics.* e Physics.*.
- 4- Clique em "Compilar & Executar (F11)": o compilador vai gerar um aplicativo "CRs.exe" e executa-lo. Voce pode tambem executar o programa clicando duas vezes no aplicativo.

Rodando em Linux/IOS:

- 1- baixe o arquivo Makefile e o tarball CRs.tgz e descompacte-o: "tar xzvf CRs.tgz" ou "make install" (sem as aspas)
- 2- entre na pasta "CRs": "cd CRs"
- 3- (opcional) comentar a linha 31 do arquivo Main.cc, ou seja, inserir 2 barras "/" (sem as aspas) antes de: system("pause");
- 4- compile digitando "make" (sem as aspas)
- em caso de erro de compilacao, digite antes "make clean" e depois "make" (sem as aspas)
- 5- Execute o programa, digitando: "./CRs" (sem as aspas)

Neste ponto, ao ser executado, o programa escreve no terminal:

```
*****COSMIC RAYS*****
```

Pressione qualquer tecla para continuar ...
(Press any key to continue ...)

Tudo certo? Prontos para o primeiro exercicio?

Ex.1) Incluir a classe Atmosphere

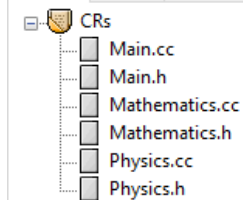
No DeV:

- 1- na aba Projeto(Project) a esquerda clique com o botao da direita sobre CRs e adicione ao projeto (Add to Project) os arquivos: Atmosphere.cc e Atmosphere.h
- 2- no arquivo Main.h: descomente a linha 9 (delete as barras "/"): #include "Atmosphere.h"

← → ↕ ↑ 📁 > CRs > CRs

- 📁 .dropbox.cache
- 📁 Camera Uploads
- 📁 Capturas de tela
- 📁 finanças
- 📁 FisNucl (Conflito de sincronizaç
- 📁 home
- 📁 Public
- 📁 solar
- 📁 tmp
- 📁 Viagens
- 📁 work
- ☁ OneDrive - Personal
 - 📁 Anexos de email
 - 📁 Apps
 - 📁 Área de Trabalho
 - 📁 Arquivos de Microsoft Copilot C
 - 📁 Documentos
 - 📁 Imagens
 - 📁 Música
 - 📁 Vídeos

Nome	Status	Data de modificação	Tipo	Tamanho
📁 Atmosphere	✓	08/06/2018 18:23	Arquivo CC	4 KB
📁 Atmosphere	✓	08/06/2018 18:14	Arquivo DAT	47 KB
📁 Atmosphere	✓	07/05/2018 12:14	C Header File	1 KB
📁 CRs	✓	19/05/2020 12:23	Arquivo	10 KB
📁 CRs	✓	19/06/2018 11:10	Dev-C++ Project ...	2 KB
📁 CRs	✓	05/06/2025 16:35	Aplicativo	290 KB
📁 CRs.layout	✓	05/06/2025 16:48	Arquivo LAYOUT	1 KB
📁 g++dep	✓	22/06/2011 10:55	Arquivo	2 KB
📄 LEIAME	✓	19/05/2020 17:24	Documento de Te...	4 KB
📁 Main	✓	19/05/2020 12:04	Arquivo CC	1 KB
📁 Main	✓	19/05/2020 12:04	C Header File	1 KB
📁 Main.o	✓	05/06/2025 16:35	Arquivo O	2 KB
📄 Makefile	✓	19/06/2018 12:41	Arquivo	3 KB
📄 Makefile.win	✓	05/06/2025 16:37	Arquivo WIN	2 KB
📁 Mathematics	✓	07/05/2018 12:22	Arquivo CC	1 KB
📁 Mathematics	✓	07/05/2018 12:22	C Header File	1 KB
📁 Mathematics.o	✓	05/06/2025 16:35	Arquivo O	1 KB
📁 Physics	✓	07/05/2018 12:22	Arquivo CC	1 KB
📁 Physics	✓	07/05/2018 12:22	C Header File	1 KB
📁 Physics.o	✓	05/06/2025 16:35	Arquivo O	1 KB



```
1 // Prog.cc
2 // This Program is
3
4 #include "Main.h"
5 int main (int par_exec1, char* pars_exec[])
6 {
7 //Objects creation
8     Mathematics * Math = new Mathematics();
9     Physics * Phys = new Physics();
10 // Atmosphere * Atm = new Atmosphere();
11
12     printf("*****COSMIC RAYS*****\n\n");
13
14 //Methods (functions) of the classes are called
15     Math->fMath1();
16     Math->fMath2();
17     Phys->fPhys1();
18     Phys->fPhys2();
19
20
21 //Calls Atmosphere and print its data
22 /* Atm->Init(altitude,temperature,pressure,density);
23     for(i=0;i<=1480;i++){
24         double alt=Atm->GetAltitude(i,altitude);
25         double temp=Atm->GetTemperature(i,temperature);
26         double press=Atm->GetPressure(i,pressure);
27         double dens=Atm->GetDensity(i,density);
28         printf("i= %d, h= %.3f km, T= %.3f oC, P= %.3f hPa, dens= %.3f kg/m3\n",i,alt,temp,press,dens);
29     }*/
30
31     system("pause");
32     return 0;
33 }
```

Arquivo Editar Localizar Exibir Projeto Executar Ferramentas AStyle Janela Ajuda

TDM-GCC 4.9.2 32-bit Release

(globals)

Projeto Classes De Main.cc Main.h Mathematics.cc Mathematics.h Physics.cc Physics.h

CRs
Main.cc
Main.h
Mathematics.cc
Mathematics.h
Physics.cc
Physics.h

```
1 // System Headers
2
3 #include <stdio.h>
4 #include <string.h>
5 #include <stdlib.h>
6
7 #include "Mathematics.h"
8 #include "Physics.h"
9 //#include "Atmosphere.h"
10
11 //Global variables
12
13 char ch;
14 char string[8],line[100];
15 int i,j,k,l;
16 double altitude[1481],temperature[1481],pressure[1481],density[1481];
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
```

CRs - [CRs.dev] - Dev-C++ 5.11

Arquivo Editar Localizar Exibir Projeto Executar Ferramentas AStyle Janela Ajuda

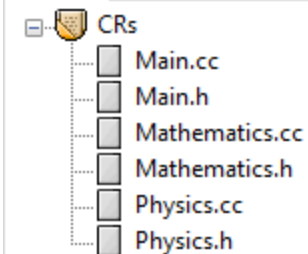
TDM-GCC 4.9.2 32-bit Release

(globals)

Projeto Classes De Main.cc Main.h Mathematics.cc Mathematics.h Physics.cc Physics.h

- CRs
 - Main.cc
 - Main.h
 - Mathematics.cc
 - Mathematics.h
 - Physics.cc
 - Physics.h

```
1 //Mathematics.cc
2
3 // System Headers:
4 #include <stdlib.h>
5
6 // Local Headers:
7 #include "Mathematics.h"
8
9 // Constructor
10 Mathematics::Mathematics ( )
11 {
12 }
13
14 // Destructor
15 Mathematics::~Mathematics ( )
16 {
17 }
18
19
20
21 //Code of func1_1
22 float Mathematics::fMath1(void)
23 {
24 // algorithm
25 a=0;
26 b=1;
27 c=2*a+b;
28 return 0;
29 }
30
31
32 //Code of func2_1
33 float Mathematics::fMath2(void)
34 {
35 // algorithm
36 return 0;
37 }
38
39
40
```



```
1 // System Headers
2 #include <iostream.h>
3 #include <sstream.h>
4 #include <math.h>
5
6 class Mathematics
7 {
8     private:
9         float a,b,c;
10        //double ;
11
12     public:
13         #define pi 3.141592654
14         #define rad2deg (180./pi)
15
16        /// Constructor of the class.
17        Mathematics ( );
18
19        /// Destructor of the class.
20        ~Mathematics ( );
21
22        ///Declaration of the method Mathematics
23        float fMath1(void);
24
25        ///Declaration of the method Mathematics
26        float fMath2(void);
27    };
28
29
30
31
32
33
34
35
```

- CRs
 - Main.cc
 - Main.h
 - Mathematics.cc
 - Mathematics.h
 - Physics.cc
 - Physics.h

```
1 //Physics.cc
2
3 // System Headers:
4 #include <stdlib.h>
5
6 // Local Headers:
7 #include "Physics.h"
8
9
10 // Constructor
11 Physics::Physics ( )
12 {
13 }
14
15
16 // Destructor
17 Physics::~Physics ( )
18 {
19 }
20
21
22 //Codigo da func1_2
23 float Physics::fPhys1(void)
24 {
25     // algorithm
26     return 0;
27 }
28
29
30 //Code of func2_2
31 float Physics::fPhys2(void)
32 {
33     // algorithm
34     return 0;
35 }
36
37
38
```

(globals)

Projeto Classes De Main.cc Main.h Mathematics.cc Mathematics.h Physics.cc Physics.h

CRs

- Main.cc
- Main.h
- Mathematics.cc
- Mathematics.h
- Physics.cc
- Physics.h

```
1 // System Headers
2 //include <iostream.h>
3 //include <sstream.h>
4 #include <math.h>
5
6 class Physics
7 {
8     private:
9         //double ;
10
11     public:
12         ///! Constructor of the class.
13         Physics ( );
14
15         ///! Destructor of the class.
16         ~Physics ( );
17
18         //declaration of the method Physics
19         float fPhys1(void);
20
21         //declaration of the method Physics
22         float fPhys2(void);
23     };
24
25
26
27
28
29
30
31
32
```

Arquivo Editar Localizar Exibir Projeto Executar Ferramentas AStyle Janela Ajuda

TDM-GCC 4.9.2 32-bit Release

(globals)

Projeto Classes De

CRs

- Main.cc
- Main.h
- Mathematics.cc
- Mathematics.h
- Physics.cc
- Physics.h

```
1 // Prog.cc
2 // This Program is
3
4 #include "Main.h"
5 int main (int par_exec1, char* pars_exec[])
6 {
7 //Objects creation
8     Mathematics * Math = new Mathematics();
9     Physics * Phys = new Physics();
10 // Atmosphere * Atm = new Atmosphere();
11
12     printf("*****COSMIC RAYS*****\n\n");
13
14 //Methods (functions) of the classes are called
15     Math->fMath1();
16     Math->fMath2();
17     Phys->fPhys1();
18     Phys->fPhys2();
19
20
21 //Calls Atmosphere and print its data
22 /* Atm->Init(altitude,temperature,pressure,density);
23     for(i=0;i<=1480;i++){
24         double alt=Atm->GetAltitude(i,altitude);
25         double temp=Atm->GetTemperature(i,temperature);
26         double press=Atm->GetPressure(i,pressure);
27         double dens=Atm->GetDensity(i,density);
28         printf("i= %d, h= %.3f km, T= %.3f oC, P= %.3f hPa, dens= %.3f kg/m3\n",i,alt,temp,press,dens);
29     }*/
30
31     system("pause");
32     return 0;
33 }
```

Compilador Recursos Registro do Compilador Depurador Resultados da Busca

Arquivo Editar Localizar Exibir Projeto Executar Ferramentas AStyle Janela Ajuda

TDM-GCC 4.9.2 32-bit Release

(globals)

Projeto Classes

- CRs
 - Main.cc
 - Main.h
 - Mathem
 - Mathem
 - Physics.c
 - Physics.h

C:\Users\leigui\OneDrive\Desktop\CRs\CRs\CRs.exe

```
*****COSMIC RAYS*****  
Pressione qualquer tecla para continuar. . .
```

Compilador Recursos Registro do Compilador Depurador Resultados da Busca Fechar

Abortar Compilação

Shorten compiler paths

```
Compilation results...  
-----  
- Errors: 0  
- Warnings: 0  
- Output Filename: C:\Users\leigui\OneDrive\Desktop\CRs\CRs\CRs.exe  
- Output Size: 289,2490234375 KiB  
- Compilation Time: 0,80s
```

- New File
- Adicionar ao Projeto
- Remover do Projeto
- Adicionar pasta
- Opções do Projeto Ctrl+H
- Fechar Projeto

```
1 // Prog.cc
2 // This Program is
3 //
4 //
5 //
6 //
7 //
8 //
9 //
10 //
11 //
12 //
13 //
14 //Methods (functions) of the classes are called
15 Math->fMath1();
16 Math->fMath2();
17 Phys->fPhys1();
18 Phys->fPhys2();
19 //
20 //
21 //Calls Atmosphere and print its data
22 /* Atm->Init(altitude, temperature, pressure, density);
23 for(i=0; i<=1480; i++){
24     double alt=Atm->GetAltitude(i, altitude);
25     double temp=Atm->GetTemperature(i, temperature);
26     double press=Atm->GetPressure(i, pressure);
27     double dens=Atm->GetDensity(i, density);
28     printf("i= %d, h= %.3f km, T= %.3f oC, P= %.3f hPa, dens= %.3f kg/m3\n", i, alt, temp, press, dens);
29 }*/
30 //
31 system("pause");
32 return 0;
33 }
```

s AStyle Janela Ajuda

TDM-GCC 4.9.2 32-bit Release

mathematics.h Physics.cc Physics.h

```
char* pars_ex
new Mathemati
Physics();
new Atmospher
C RAYS*****\
the classes a
print its data
temperature,pre
{
GetAltitude(i,
->GetTemperatur
->GetPressure(
->GetDensity(i,
= %.3f km, T=
```

Abrir Unidade

Examinar: CRs

Nome	Status	Data de modificação	Tipo	Tamanho
exemplos	✓	01/08/2025 15:25	Pasta de arquivos	
RI x posicao - campo variavel	✓	01/08/2025 15:25	Pasta de arquivos	
testes	✓	01/08/2025 15:25	Pasta de arquivos	
trajetorias relativisticas	✓	01/08/2025 15:25	Pasta de arquivos	
Atmosphere	✓	08/06/2018 18:23	Arquivo CC	4 KB
Atmosphere	✓	08/06/2018 18:14	Arquivo DAT	47 KB
Atmosphere	✓	07/05/2018 12:14	C Header File	1 KB
Atmosphere.o	✓	07/11/2024 16:28	Arquivo O	2 KB
CRs	✓	07/11/2024 17:32	Dev-C++ Project ...	2 KB
CRs	✓	12/06/2025 12:14	Aplicativo	300 KB
CRs.layout	✓	17/06/2025 11:25	Arquivo LAYOUT	1 KB
g++-dep	✓	22/06/2011 10:55	Arquivo	2 KB
graph_from_data	✓	15/05/2025 13:37	C++ Source File	2 KB
LEIAME	✓	03/05/2023 17:45	Documento de Te...	4 KB

Nome: "Atmosphere.h" "Atmosphere.cc"

Tipo: All files (*.*)

Abrir Cancelar

Arquivo Editar Localizar Exibir Projeto Executar Ferramentas AStyle Janela Ajuda

TDM-GCC 4.9.2 32-bit Release

(globals)

Projeto Classes De

CRs

- Atmosphere.cc
- Atmosphere.h
- Main.cc
- Main.h
- Mathematics.cc
- Mathematics.h
- Physics.cc
- Physics.h

```

1 //Class to describe and calculate atmospheric parameters
2
3 // System Headers:
4 #include <stdio.h>
5
6 // Local Headers:
7 #include "Atmosphere.h"
8 // altitude kilometers
9 // temperature degrees celcius
10 // pressure mbar
11 // density kg/m3
12
13 // Constructor
14 Atmosphere::Atmosphere(){}
15 // Destructor
16 Atmosphere::~Atmosphere(){}
17
18 //Method for initialization of the atmosphere from file
19 double Atmosphere::Init(double atm_alt[1481],double atm_temp[1481],double atm_press[1481],double atm_dens[1481]) {
20
21 FILE *atm_file;
22 char ch,line[100];
23 int i;
24
25 atm_file=fopen("Atmosphere.dat","r");
26 if (atm_file==NULL) {
27     (void)printf("Can't open atmosphere file\n");
28     return -1;}
29 i=0;
30 ch=fgetc(atm_file);
31 while (ch!=EOF){
32     //while(i<=1481){
33     //     (void)printf("%c",ch);
34     (void)ungetc(ch,atm_file);
35     (void)fgets(line,sizeof(line),atm_file);
    
```

- CRs
 - Atmosphere.cc
 - Atmosphere.h
 - Main.cc
 - Main.h
 - Mathematics.cc
 - Mathematics.h
 - Physics.cc
 - Physics.h

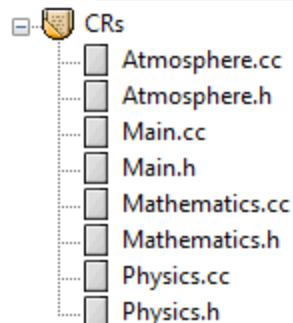
```
1 // System Headers
2 #include <math.h>
3
4 class Atmosphere
5 {
6     private:
7         //double ;
8         double atm_alt[1481],atm_temp[1481],atm_press[1481],atm_dens[1481];
9     public:
10        // Constructor of the class.
11
12        Atmosphere();
13        // Destructor of the class.
14        ~Atmosphere();
15
16        //Declaration of the methods
17        double Init(double atm_alt[1481],double atm_temp[1481],double atm_press[1481],double atm_dens[1481]);
18        double GetLevelIndexes(int& low_i, int& up_i, double atm_alt[1481], double alt);
19        double GetAltitude(int i, double atm_alt[1481]);
20        double GetTemperature(int i, double atm_temp[1481]);
21        double GetPressure(int i, double atm_press[1481]);
22        double GetDensity(int i, double atm_dens[1481]);
23        double GetDepth(double& depth, double alt);
24    };
25
26
27
28
29
```

- CRs
 - Atmosphere.cc
 - Atmosphere.h
 - Main.cc
 - Main.h
 - Mathematics.cc
 - Mathematics.h
 - Physics.cc
 - Physics.h

```

1  0.15 1013.25  1.225
2  0.025 14.8375 1010.250317 1.222063
3  0.05 14.675 1007.25783 1.219131
4  0.075 14.5125 1004.272523 1.216204
5  0.1 14.35 1001.294386 1.213283
6  0.125 14.1875 998.323403 1.210367
7  0.15 14.025 995.359563 1.207456
8  0.175 13.8625 992.402852 1.204551
9  0.2 13.7 989.453256 1.201651
10 0.225 13.5375 986.510764 1.198757
11 0.25 13.375 983.575361 1.195868
12 0.275 13.2125 980.647034 1.192984
13 0.3 13.05 977.725771 1.190106
14 0.325 12.8875 974.811559 1.187233
15 0.35 12.725 971.904384 1.184365
16 0.375 12.5625 969.004233 1.181502
17 0.4 12.4 966.111094 1.178645
18 0.425 12.2375 963.224954 1.175793
19 0.45 12.075 960.345799 1.172946
20 0.475 11.9125 957.473616 1.170105
21 0.5 11.75 954.608393 1.167269
22 0.525 11.5875 951.750117 1.164438
23 0.55 11.425 948.898775 1.161612
24 0.575 11.2625 946.054354 1.158792
25 0.6 11.1 943.216841 1.155977
26 0.625 10.9375 940.386223 1.153167
27 0.65 10.775 937.562487 1.150362
28 0.675 10.6125 934.745622 1.147563
29 0.7 10.45 931.935613 1.144769
30 0.725 10.2875 929.132448 1.14198
31 0.75 10.125 926.336114 1.139196
32 0.775 9.9625 923.546599 1.136417
33 0.8 9.8 920.76389 1.133644
34 0.825 9.6375 917.987974 1.130876
35 0.85 9.475 915.218838 1.128113

```



```
1 // Prog.cc
2 // This Program is
3 |
4 #include "Main.h"
5 int main (int par_exec1, char* pars_exec[])
6 {
7 //Objects creation
8     Mathematics * Math = new Mathematics();
9     Physics * Phys = new Physics();
10    Atmosphere * Atm = new Atmosphere();
11
12    printf("*****COSMIC RAYS*****\n\n");
13
14 //Methods (functions) of the classes are called
15    Math->fMath1();
16    Math->fMath2();
17    Phys->fPhys1();
18    Phys->fPhys2();
19
20
21 //Calls Atmosphere and print its data
22    Atm->Init(altitude,temperature,pressure,density);
23    for(i=0;i<=1480;i++){
24        double alt=Atm->GetAltitude(i,altitude);
25        double temp=Atm->GetTemperature(i,temperature);
26        double press=Atm->GetPressure(i,pressure);
27        double dens=Atm->GetDensity(i,density);
28        printf("i= %d, h= %.3f km, T= %.3f oC, P= %.3f hPa, dens= %.3f kg/m3\n",i,alt,temp,press,dens);
29    }
30
31    system("pause");
32    return 0;
33 }
```

Projeto

- CRs
 - Atmosphere.cc
 - Atmosphere.h
 - Main.cc
 - Main.h
 - Mathematics.cc
 - Mathematics.h
 - Physics.cc
 - Physics.h

```

1 // Prog.cc
2 // This Program is
3
4 #include "Main.h"
5 int main (int par_exec1, char* pars_exec[])
6 {
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
    
```

C:\Users\leigui\OneDrive\Desktop\CRs\CRs\CRs.exe

i= 1452, h= 36.300 km, T= -32.460 oC, P= 4.641 hPa, dens= 0.007 kg/m3
i= 1453, h= 36.325 km, T= -32.390 oC, P= 4.624 hPa, dens= 0.007 kg/m3
i= 1454, h= 36.350 km, T= -32.320 oC, P= 4.608 hPa, dens= 0.007 kg/m3
i= 1455, h= 36.375 km, T= -32.250 oC, P= 4.592 hPa, dens= 0.007 kg/m3
i= 1456, h= 36.400 km, T= -32.180 oC, P= 4.576 hPa, dens= 0.007 kg/m3
i= 1457, h= 36.425 km, T= -32.110 oC, P= 4.559 hPa, dens= 0.007 kg/m3
i= 1458, h= 36.450 km, T= -32.040 oC, P= 4.543 hPa, dens= 0.007 kg/m3
i= 1459, h= 36.475 km, T= -31.970 oC, P= 4.527 hPa, dens= 0.007 kg/m3
i= 1460, h= 36.500 km, T= -31.900 oC, P= 4.511 hPa, dens= 0.007 kg/m3
i= 1461, h= 36.525 km, T= -31.830 oC, P= 4.495 hPa, dens= 0.006 kg/m3
i= 1462, h= 36.550 km, T= -31.760 oC, P= 4.479 hPa, dens= 0.006 kg/m3
i= 1463, h= 36.575 km, T= -31.690 oC, P= 4.464 hPa, dens= 0.006 kg/m3
i= 1464, h= 36.600 km, T= -31.620 oC, P= 4.448 hPa, dens= 0.006 kg/m3
i= 1465, h= 36.625 km, T= -31.550 oC, P= 4.432 hPa, dens= 0.006 kg/m3
i= 1466, h= 36.650 km, T= -31.480 oC, P= 4.416 hPa, dens= 0.006 kg/m3
i= 1467, h= 36.675 km, T= -31.410 oC, P= 4.401 hPa, dens= 0.006 kg/m3
i= 1468, h= 36.700 km, T= -31.340 oC, P= 4.385 hPa, dens= 0.006 kg/m3
i= 1469, h= 36.725 km, T= -31.270 oC, P= 4.370 hPa, dens= 0.006 kg/m3
i= 1470, h= 36.750 km, T= -31.200 oC, P= 4.354 hPa, dens= 0.006 kg/m3
i= 1471, h= 36.775 km, T= -31.130 oC, P= 4.339 hPa, dens= 0.006 kg/m3
i= 1472, h= 36.800 km, T= -31.060 oC, P= 4.324 hPa, dens= 0.006 kg/m3
i= 1473, h= 36.825 km, T= -30.990 oC, P= 4.309 hPa, dens= 0.006 kg/m3
i= 1474, h= 36.850 km, T= -30.920 oC, P= 4.293 hPa, dens= 0.006 kg/m3
i= 1475, h= 36.875 km, T= -30.850 oC, P= 4.278 hPa, dens= 0.006 kg/m3
i= 1476, h= 36.900 km, T= -30.780 oC, P= 4.263 hPa, dens= 0.006 kg/m3
i= 1477, h= 36.925 km, T= -30.710 oC, P= 4.248 hPa, dens= 0.006 kg/m3
i= 1478, h= 36.950 km, T= -30.640 oC, P= 4.233 hPa, dens= 0.006 kg/m3
i= 1479, h= 36.975 km, T= -30.570 oC, P= 4.218 hPa, dens= 0.006 kg/m3
i= 1480, h= 37.000 km, T= -30.500 oC, P= 4.204 hPa, dens= 0.006 kg/m3

Compilador Recursos

Abortar Compilação

Shorten compiler paths

Compilador

-----Pressione qualquer tecla para continuar. . .

- Errors: 0

- Warnings: 0

- Output Filename: C:\Users\leigui\OneDrive\Desktop\CRs\CRs\CRs.exe

- Output Size: 291,9736328125 KiB

- Compilation Time: 0,78s

```

1 # Project: CRs
2 # Makefile created by Dev-C++ 5.11
3
4 CPP      = g++.exe
5 CC       = gcc.exe
6 WINDRES  = windres.exe
7 OBJ      = Mathematics.o Physics.o Main.o ../../../../Dropbox/work/alunos/IC/Raissa/CRs/Atmosphere.o
8 LINKOBJ  = Mathematics.o Physics.o Main.o ../../../../Dropbox/work/alunos/IC/Raissa/CRs/Atmosphere.o
9 LIBS     = -L"C:/Program Files (x86)/Dev-Cpp/MinGW64/lib32" -L"C:/Program Files (x86)/Dev-Cpp/MinGW64/x86_64-w64-mingw32/lib32" -static-libgcc -m32
10 INCS    = -I"C:/Program Files (x86)/Dev-Cpp/MinGW64/include" -I"C:/Program Files (x86)/Dev-Cpp/MinGW64/x86_64-w64-mingw32/include" -I"C:/Program Files (x86)/Dev-Cpp/MinGW64/lib/gcc/x86_64-w64-mi
11 CXXINCS = -I"C:/Program Files (x86)/Dev-Cpp/MinGW64/include" -I"C:/Program Files (x86)/Dev-Cpp/MinGW64/x86_64-w64-mingw32/include" -I"C:/Program Files (x86)/Dev-Cpp/MinGW64/lib/gcc/x86_64-w64-mi
12 BIN     = CRs.exe
13 CXXFLAGS = $(CXXINCS) -m32
14 CFLAGS  = $(INCS) -m32
15 RM      = rm.exe -f
16
17 .PHONY: all all-before all-after clean clean-custom
18
19 all: all-before $(BIN) all-after
20
21 clean: clean-custom
22      $(RM) $(OBJ) $(BIN)
23
24 $(BIN): $(OBJ)
25      $(CPP) $(LINKOBJ) -o $(BIN) $(LIBS)
26
27 Mathematics.o: Mathematics.cc
28      $(CPP) -c Mathematics.cc -o Mathematics.o $(CXXFLAGS)
29
30 Physics.o: Physics.cc
31      $(CPP) -c Physics.cc -o Physics.o $(CXXFLAGS)
32
33 Main.o: Main.cc
34      $(CPP) -c Main.cc -o Main.o $(CXXFLAGS)

```




























Lin...	Col...	Unidade	Mensagem
		C:\Program Files (x86)\Dev-Cpp\MinGW64\x86_64-w64...	cannot open output file CRs.exe: Permission denied
		C:\Users\leigui\OneDrive\Desktop\CRs\CRs\collect2.exe	[Error] ld returned 1 exit status
25		C:\Users\leigui\OneDrive\Desktop\CRs\CRs\Makefile.win	recipe for target 'CRs.exe' failed

Projeto Classes

```
C:\Users\leigui\OneDrive\Desktop\CRs\CRs\CRs.exe  
*****COSMIC RAYS*****  
Pressione qualquer tecla para continuar. . .
```

Abortar Compilação
 Shorten compiler paths

```
Compilation results...  
-----  
- Errors: 0  
- Warnings: 0  
- Output Filename: C:\Users\leigui\OneDrive\Desktop\CRs\CRs\CRs.exe  
- Output Size: 289,2490234375 KiB  
- Compilation Time: 0,80s
```

 ex6.txt	2016-08-01 14:42 1.4K
 ex7.txt	2016-08-01 14:42 796
 example01.cpp	2016-08-01 14:42 573
 example01_A.cpp	2016-08-01 14:42 518
 example01_B.cpp	2016-08-01 14:42 575
 example02.cpp	2016-08-01 14:42 503
 example03.cpp	2016-08-01 14:42 729
 example03_A.cpp	2016-08-01 14:42 960
 example04.cpp	2016-08-01 14:42 908
 example05.cpp	2016-08-01 14:42 1.7K
 expo.dat	2016-08-01 14:42 866
 macro1.c	2016-08-01 11:21 1.7K
 macro1_GUI.c	2016-08-08 10:32 2.2K
 macro2.c	2016-08-01 12:17 738
 macro2_input.txt	2016-08-01 12:19 157
 macro2_input_expecte_>	2016-08-01 13:10 154
 macro3.c	2016-08-01 13:28 485
 macro4.c	2016-08-01 13:31 1.1K
 macro5.c	2016-08-01 13:44 892
 macro6.c	2016-08-01 13:42 1.6K
 macro7.c	2016-08-08 11:47 937
 read_from_file.c	2016-08-08 12:17 233
 read_long.c	2016-08-08 10:01 15K
 read_long.cc	2016-08-08 09:58 9.1K
 root_v5.34.38.win32_>	2020-05-19 18:55 47M
 slits.c	2016-08-01 10:13 1.1K
 write_to_file.c	2016-08-08 12:04 349



The image shows a Windows 10 desktop with a blue background. The Start menu search bar is open, displaying the search term "cmd". The search results are categorized into several sections:

- Melhor correspondência** (Best match):
 - Prompt de Comando (Sistema)
- Aplicativos** (Apps):
 - Microsoft Azure Command Prompt - v2.9
 - Anaconda Prompt
 - x64 Native Tools Command Prompt for VS 2022
- Documentos** (Documents):
 - cmdserver
 - cmdline.cpython-312 - em __pycache__
 - cmdline.cpython-312 - em __pycache__
- Pesquisar na Web** (Search on the web):
 - cmd - Ver mais resultados da pesquisa
- Fotos** (Photos):
 - Cmd03erro
 - Cmd05erro - em img00

The search bar at the bottom left shows the text "cmd". The taskbar at the bottom contains icons for the Start menu, Search, Task View, File Explorer, Microsoft Edge, Outlook, Word, Chrome, Task View, Photos, and Adobe Reader. The system tray on the right shows the date and time as 25-08-2023 17:38.

ROOT session

Microsoft Windows [versão 10.0.19045.6216]
(c) Microsoft Corporation. Todos os direitos reservados.

C:\Users\leigui>root

```
*****  
*                                     *  
*      W E L C O M E  t o  R O O T      *  
*                                     *  
*  Version   5.34/38      12 March 2018 *  
*                                     *  
*  You are welcome to visit our Web site *  
*      http://root.cern.ch              *  
*                                     *  
*****
```

ROOT 5.34/38 (v5-34-38@v5-34-38, Mar 12 2018, 15:49:39 on win32)

ROOT C/C++ Interpreter version 5.18.00, July 2, 2010
Type ? for help. Commands must be C++ statements.
Enclose multiple statements between { }.
root [0] .q_

Pesquisar na Web

- cmd - Ver mais resultados da pesquisa >

Fotos

- Cmd03erro >
- Cmd05erro - em img00 >

cmd

An Introduction to ROOT

ROOT

An Object-Oriented
Data Analysis Framework



