

# Computational Astrophysics — Exercise 1

## 1 Problem

- Install a C, C++, Fortran compiler (plus linker) on your system. Possible choices are, for example, gcc or PGI (free license available).
- Find out how to use the compiler to create optimized, vectorized and OpenMP parallelised code.
- Can the compiler process OpenACC directives and if so, for which GPUs or CPUs?

## 2 Problem

- a) Write a program (in C, C++ or Fortran), which executes the loop

$$c[i] = a[i] b[i]$$

on the vectors

$$a = (0, 1, \dots, n)^T \text{ und } b = (n, n-1, \dots, 0)^T$$

for  $i = 0, \dots, n$ . Measure the (wallclock) time that the program needs to run in debug mode.

- b) Compile the program again, this time using vectorization. What are the correspondings flags for the compiler? How long does the execution of the optimized loop take compared to a)?
- c) Now use OpenMP to parallelize the loop. How does the execution time change?
- d) (optional!) Use OpenACC to parallelize the loop and compare results and times.

## 3 Problem

Write a program that multiplies the  $n \times n$  matrices

$$A = \begin{pmatrix} 2 & 4 & \dots & 4 \\ 5 & \ddots & \ddots & \vdots \\ \vdots & \ddots & \ddots & 4 \\ 5 & \dots & 5 & 2 \end{pmatrix} \text{ und } B = \begin{pmatrix} 1 & 6 & \dots & 6 \\ 3 & \ddots & \ddots & \vdots \\ \vdots & \ddots & \ddots & 6 \\ 3 & \dots & 3 & 1 \end{pmatrix}$$

and optimize it:

- a ] through automatic vectorization
- b ] with OpenMP.
- c ] with OpenACC (optional).

Compare the run times for these options.