Topical Problems of Fluid Mechanics 2016

Modeling gravity-driven rivulet on a monotonically varying incline

Martin Isoz

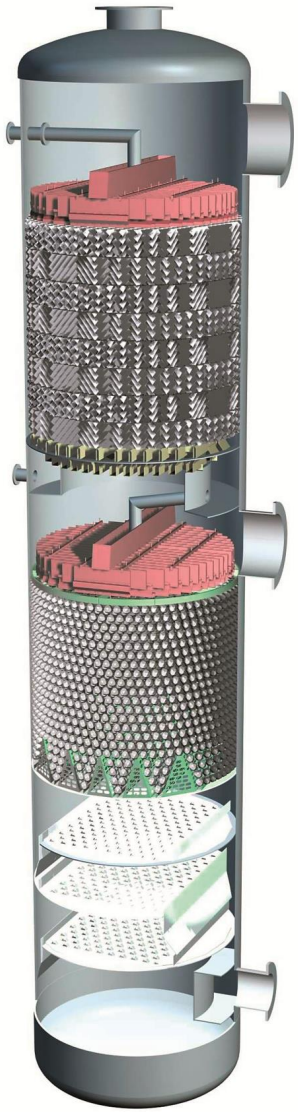
UCT Prague,
Department of mathematics

February 10–12, 2016

Introduction

Why to pay attention to a flow on a plate

Numerous applications, our concentration lies in decyphering flow in separation columns



[Sulzer ChemTech]

Hydrodynamics

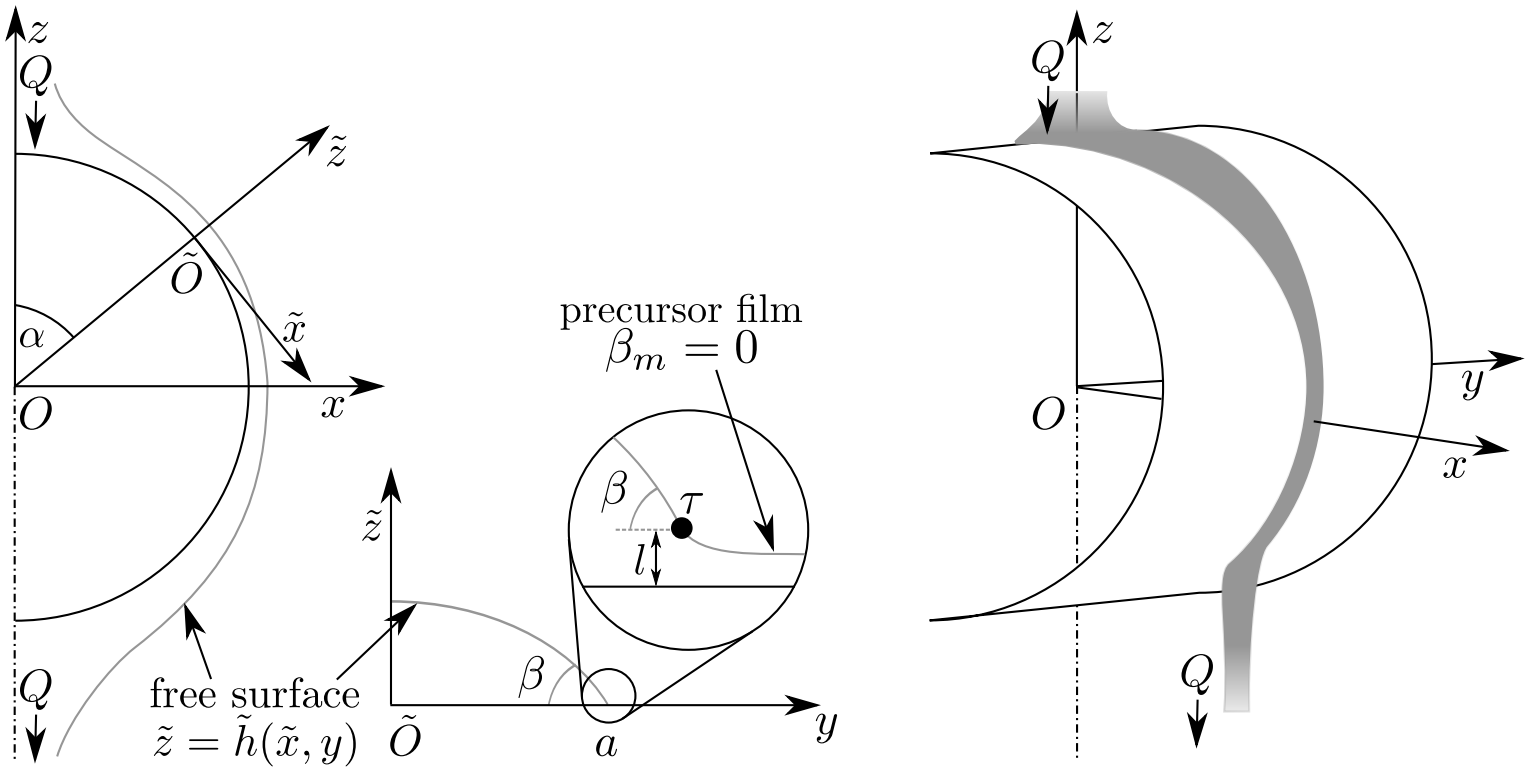
- Fuel cells
  - water management inside PEMFC fuel cells
- Aerospace engineering
  - in flight formation of rivulets on plane wings

Gas-liquid interface

- Packed columns
  - wetting performance
  - mass transfer coefficients
- Catalytic reactors
  - wetting of the catalyst

Used coordinate system

Cartesian coordinate system and basic notations



Notations

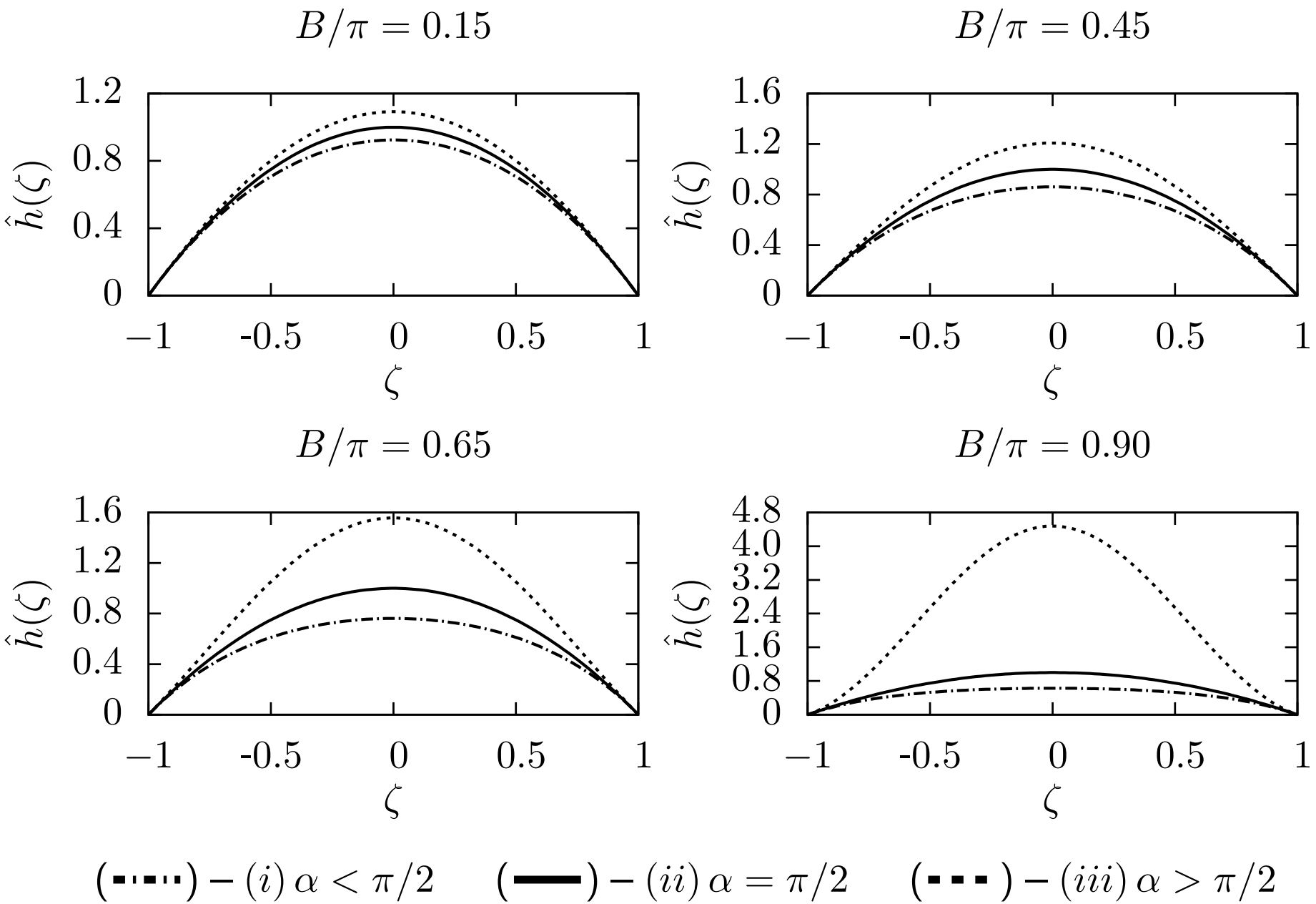
a ..... half-width of the rivulet, $[\mathrm{m}]$
$h|\tilde{h}$ ..... height, $[\mathrm{m}]$
l .. intermed. region length scale, $[\mathrm{m}]$

$x|\tilde{x}, y|\tilde{y}, z|\tilde{z}$ .. coordinate system, $[\mathrm{m}]$
α .... substrate inclination angle, $[-]$
β ..... dynamic contact angle, $[-]$

Compared methods

Effects of Bond number on GL interface shape

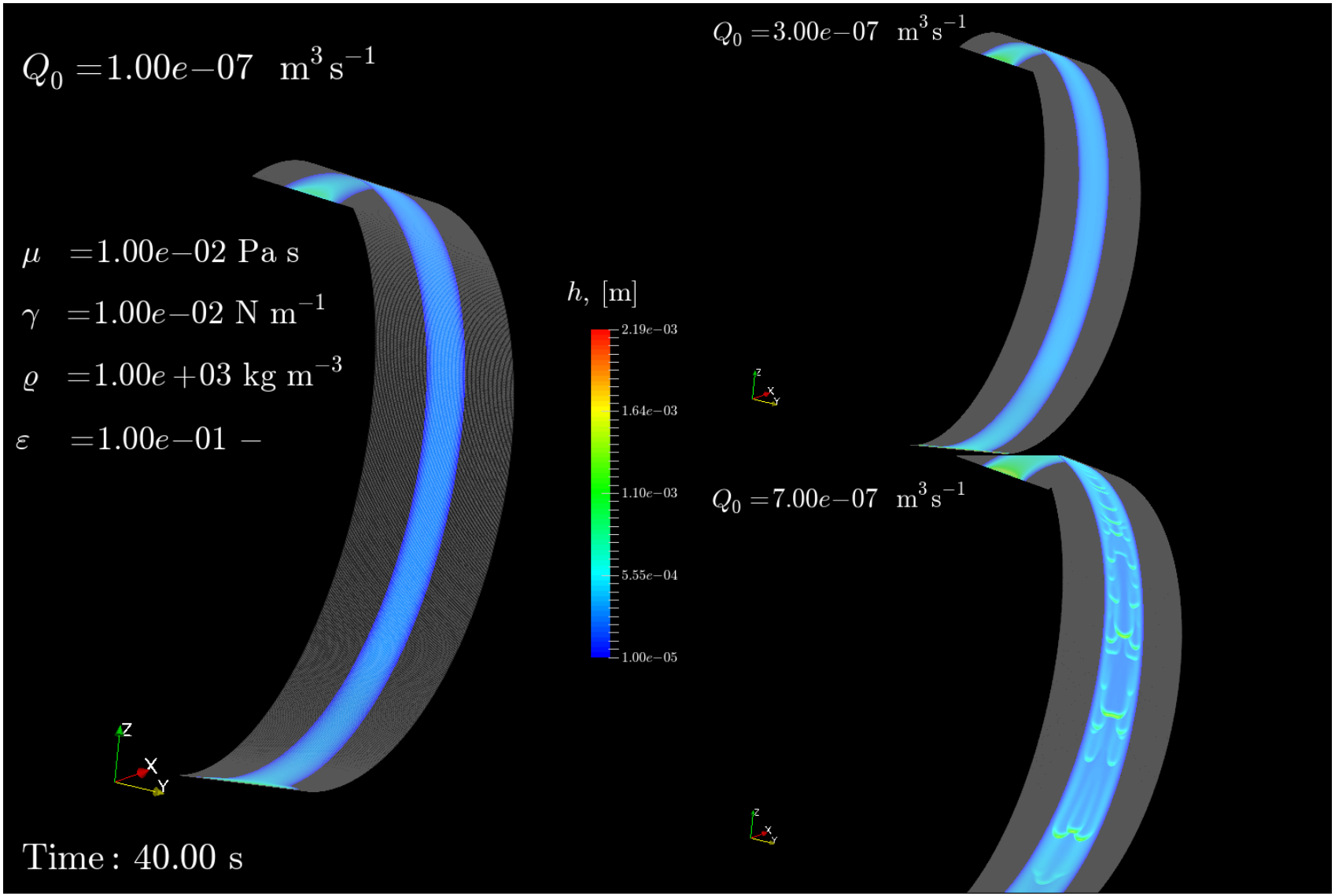
Dependence of GL interface shape on the ratio of surface and volumetric forces



Results

Short note before proceeding

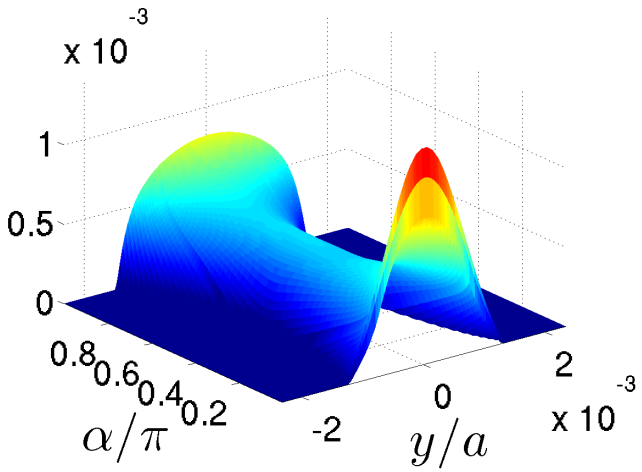
How much approximate are the results?



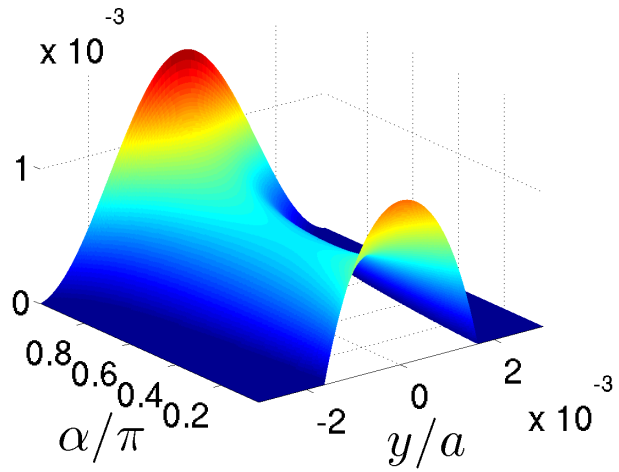
Comparison of the presented methods

Complete rivulet profiles, $Q = 1 \cdot 10^{-7}\,\mathrm{m^3 s^{-1}}$

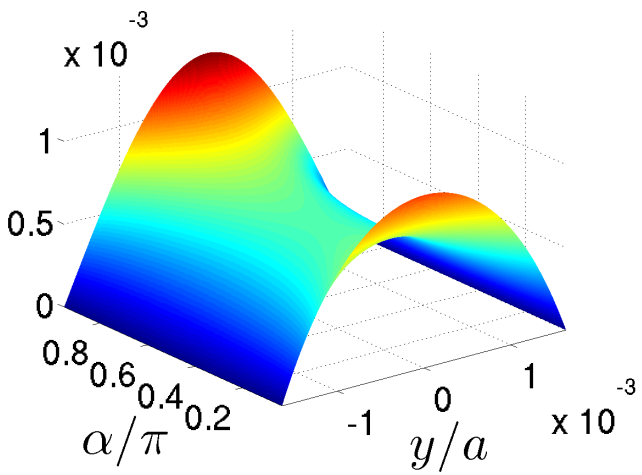
CFD



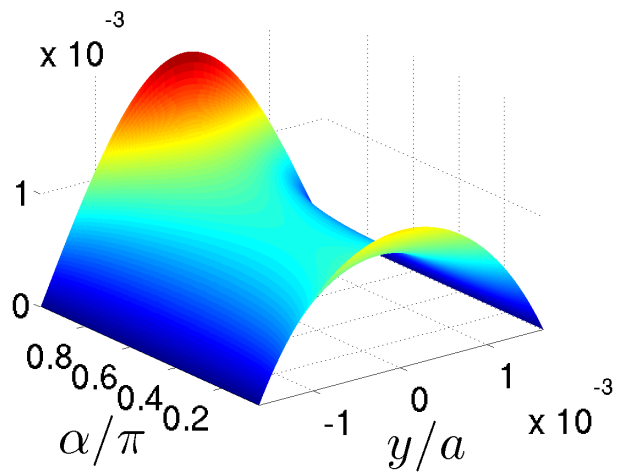
Varying both β and a



β changed, a constant

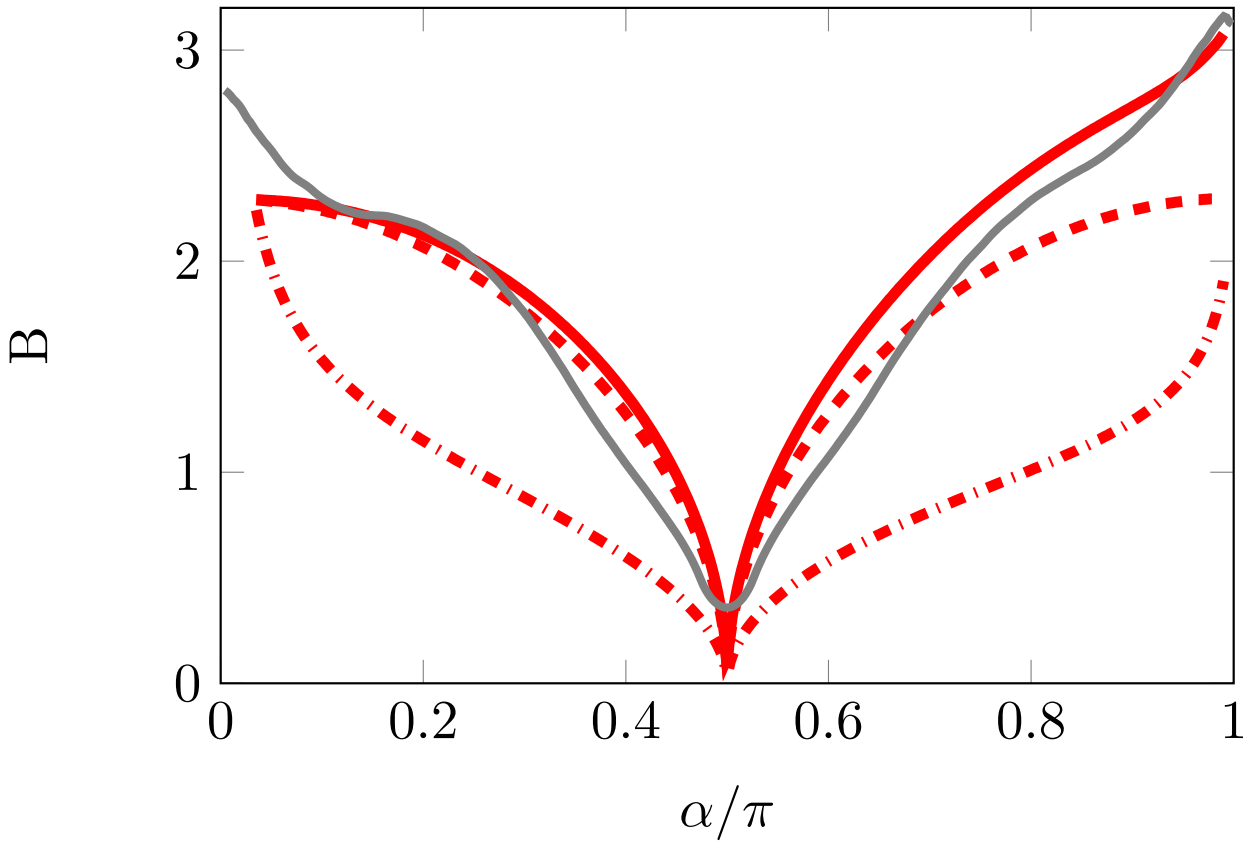


β constant, a changed



Comparison of the presented methods

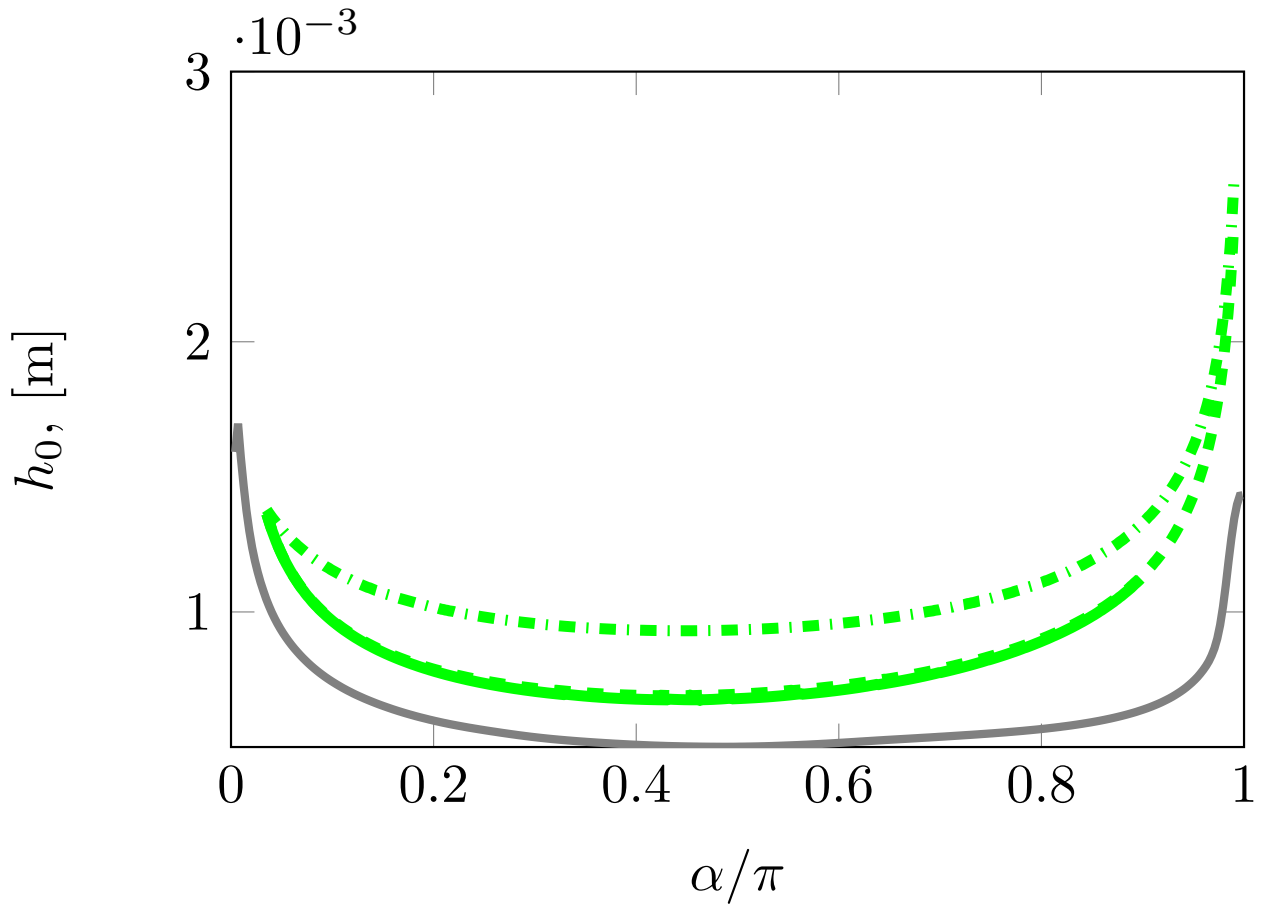
Dependence of the rivulet Bond number on the substrate inclination, $Q = 2 \cdot 10^{-7}\ \mathrm{m^3 s^{-1}}$



(——) – β and a variable
(- - -) – fixed β
(·····) – fixed a
(——) – CFD

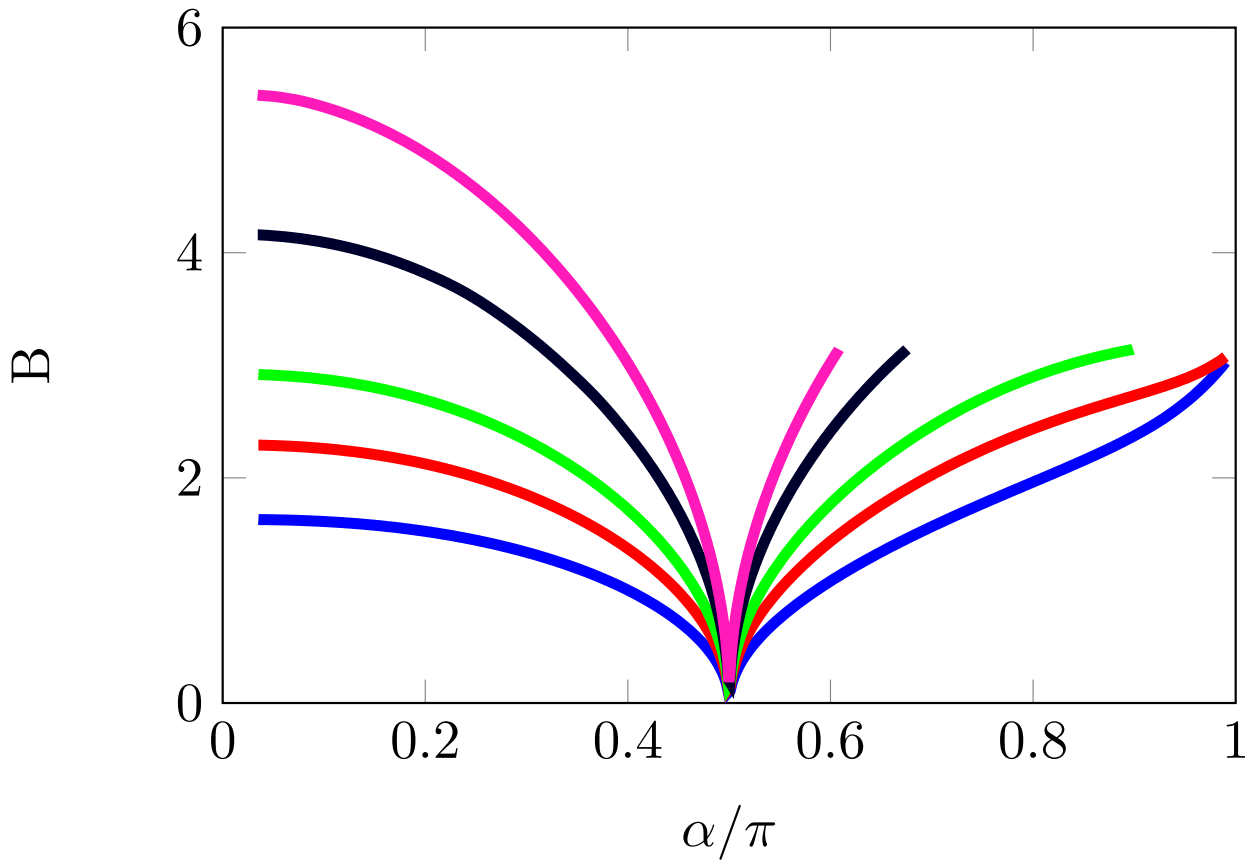
Comparison of the presented methods

Dependence of the rivulet maximal height the substrate inclination, $Q = 3 \cdot 10^{-7}\,\mathrm{m^3 s^{-1}}$



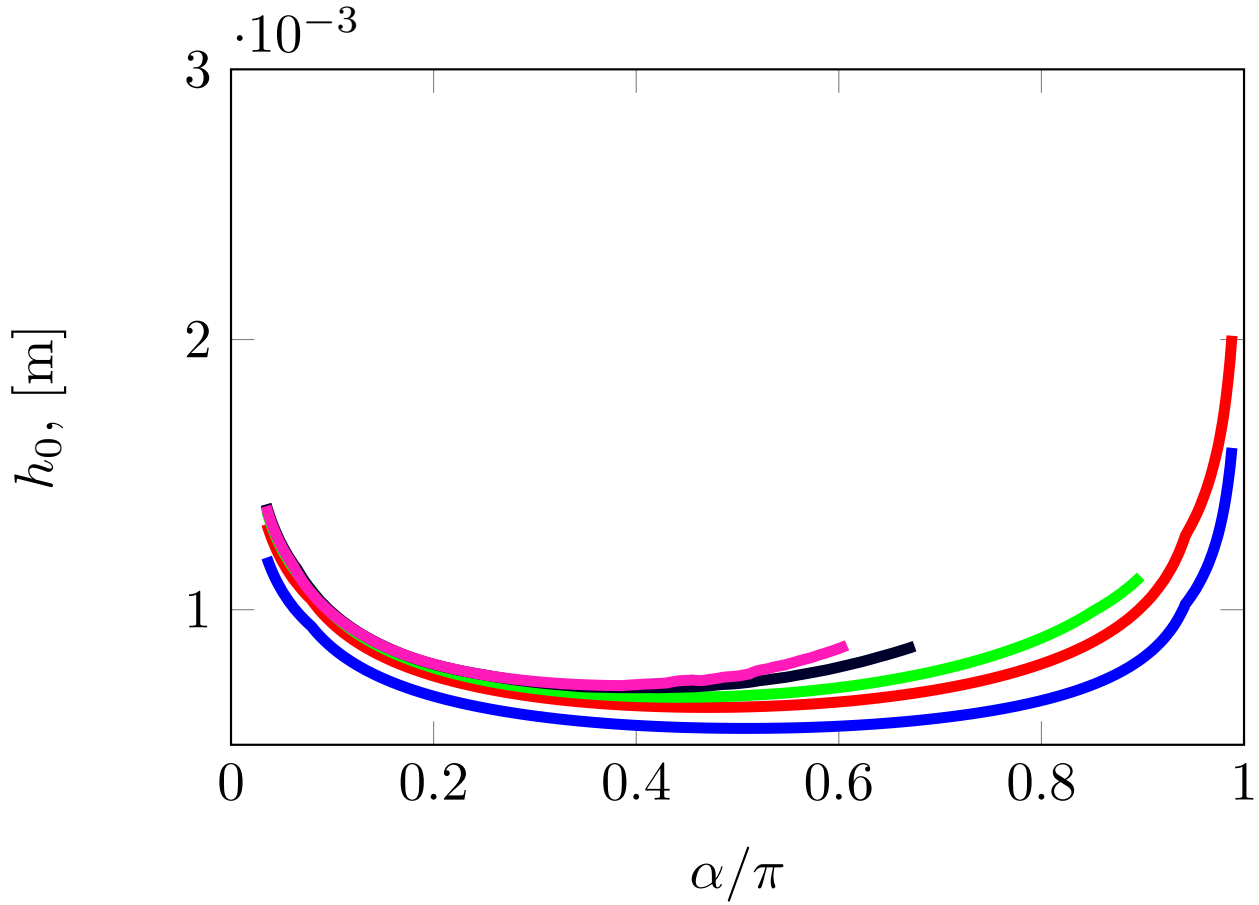
Results of the new method

Dependence of the rivulet Bond number on the substrate inclination



Results of the new method

Dependence of the rivulet maximal height on the substrate inclination



(—) $-\ Q = 1 \cdot 10^{-7}$ (—) $-\ Q = 2 \cdot 10^{-7}$ (—) $-\ Q = 3 \cdot 10^{-7}$

(—) $-\ Q = 5 \cdot 10^{-7}$ (—) $-\ Q = 7 \cdot 10^{-7}$ $[\mathrm{m^3\,s^{-1}}]$

Conclusion

Thank you for your attention