This article was downloaded by:[Shchekin, A. K.] On: 19 December 2007 Access Details: [subscription number 788674387] Publisher: Taylor & Francis Informa Ltd Registered in England and Wales Registered Number: 1072954 Registered office: Mortimer House, 37-41 Mortimer Street, London W1T 3JH, UK



# Molecular Physics An International Journal in the Field of Chemical Physics

#### Publication details, including instructions for authors and subscription information: http://www.informaworld.com/smpp/title~content=t713395160

## On the definition of the disjoining pressure of a

## wedge-shaped film

A. I. Rusanov<sup>a</sup>; A. K. Shchekin <sup>a</sup> Mendeleev Centre, Russia

Online Publication Date: 01 December 2007 To cite this Article: Rusanov, A. I. and Shchekin, A. K. (2007) 'On the definition of the disjoining pressure of a wedge-shaped film', Molecular Physics, 105:23, 3185 - 3186 To link to this article: DOI: 10.1080/00268970701802440 URL: http://dx.doi.org/10.1080/00268970701802440

#### PLEASE SCROLL DOWN FOR ARTICLE

Full terms and conditions of use: http://www.informaworld.com/terms-and-conditions-of-access.pdf

This article maybe used for research, teaching and private study purposes. Any substantial or systematic reproduction, re-distribution, re-selling, loan or sub-licensing, systematic supply or distribution in any form to anyone is expressly forbidden.

The publisher does not give any warranty express or implied or make any representation that the contents will be complete or accurate or up to date. The accuracy of any instructions, formulae and drug doses should be independently verified with primary sources. The publisher shall not be liable for any loss, actions, claims, proceedings, demand or costs or damages whatsoever or howsoever caused arising directly or indirectly in connection with or arising out of the use of this material.



### Erratum

# On the definition of the disjoining pressure of a wedge-shaped film

A. I. RUSANOV and A. K. SHCHEKIN\*

Mendeleev Centre, St. Petersburg State University, 199034 St. Petersburg, Russia

(Received 28 October 2007; in final form 11 November 2007)

An erratum is corrected concerning the definition of the disjoining pressure of a wedge-shaped film in the previous publication of the authors

In the text of our previous article [1], it was assumed that the structure of the pressure tensor corresponds to that of the metric tensor of a system in the absence of external fields. This assumption is intuitive and has never been proven, and turns out not always to be valid. In particular, it is invalid in the case of the wedge-shaped film considered in our article, among other examples.

Let a wedge-shaped film of phase  $\alpha$  form in between walls  $\beta$  and  $\gamma$  (figure 1). The cylindrical coordinate system r,  $\varphi$ , z (with the z axis along the edge) diagonalizes the metric tensor, but does not diagonalize the pressure tensor in this case. Indeed, in view of the fact that surface layer overlapping increases to the edge vertex, the vector **p** of the force applied to the unit surface of wall  $\gamma$  of the wedge is evidently not normal to the wall and should have a certain inclination to the left where the attraction from wall  $\beta$  is stronger than on the right. This means that not only  $p_{\varphi\varphi}$ , but also the component  $p_{r\varphi}$  of the pressure tensor is not zero, and the known mechanical equilibrium condition holds

$$\frac{1}{r}\frac{\partial p_{\varphi\varphi}}{\partial\varphi} + \frac{2p_{r\varphi}}{r} + \frac{\partial p_{r\varphi}}{\partial r} = 0$$
(1)

throughout the wedge-shaped film.

It is of note that equation (1) itself does not prohibit the condition

$$\frac{\partial p_{\varphi\varphi}}{\partial\varphi} = 0, \tag{2}$$

which can be satisfied if the condition

$$\frac{2p_{r\varphi}}{r} + \frac{\partial p_{r\varphi}}{\partial r} = 0 \tag{3}$$

is fulfilled separately. Moreover, one can show that equation (2) is inevitably fulfilled in the middle of the wedge. Let us denote the values of the normal component  $p_{\varphi\varphi}$  at the wedge walls  $\beta$  and  $\gamma$  as  $p_{\varphi\varphi}^{\beta}$  and  $p_{\varphi\varphi}^{\gamma}$ , respectively. If one alternatively rotates wall  $\beta$  or wall  $\gamma$  in the direction to the opposite wall by the same elementary angle  $d\varphi$ , the two final states are obviously physically indistinguishable from each other if the wall areas are equal. This means that elementary work done per unit area  $p_{\varphi\varphi}^{\beta}rd\varphi$  and  $p_{\varphi\varphi}^{\gamma}rd\varphi$  are equal, and, consequently,  $p_{\varphi\varphi}^{\beta} = p_{\varphi\varphi}^{\gamma}$  irrespective of whether walls  $\beta$  and  $\gamma$  are of the same or different nature. If  $p_{\varphi\varphi}$  is a variable quantity, symmetrical character of the above equality requires the existence of the condition expressed in equation (2) in the middle of the wedge.

If, however,  $p_{\varphi\varphi}$  is a function of  $\varphi$  (even a symmetrical one), the definition of the disjoining pressure should be referred to a certain specified value of the function. Considering the transitional zone of a meniscus [1], we used the the normal pressure at a flat solid surface for the definition of the disjoining pressure. The same can



Figure 1. A wedge-shaped film.

\*Corresponding author. Email: akshch@list.ru

Molecular Physics ISSN 0026–8976 print/ISSN 1362–3028 online © 2007 Taylor & Francis http://www.tandf.co.uk/journals DOI: 10.1080/00268970701802440 be done in the case of a wedge-shaped film. Since the wedge walls are flat, there is no contribution from capillary pressure at the wall, and the pressure variation can be assined only to the disjoining pressure. So we define the disjoining pressure  $\Pi$  of a wedgeshaped film as

$$\Pi \equiv p^{\beta}_{\varphi\varphi} - p^{\alpha} = p^{\gamma}_{\varphi\varphi} - p^{\alpha} \tag{4}$$

where  $p^{\alpha}$  is pressure in the bulk phase  $\alpha$  at a broad part of the wedge-shaped film. Equation (4) rectifies the definition of the disjoining pressure of a wedge-shaped film given in [1].

#### Reference

 A. I. Rusanov and A. K. Shchekin, Mol. Phys. 103, 2911 (2005).