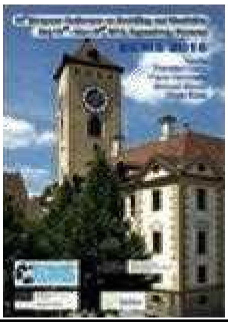
Title:	***Modeling And Analysis Of Spin Splitting In Strained Graphene Nanoribbons***
Authors:	*Sanjay Prabhakar, Roderick Melnik, Luis Bonilla*
Published in: 	(2016).ECMS 2016 Proceedings edited by: Thorsen Claus, Frank Herrmann, Michael Manitz, Oliver Rose, European Council for Modeling and Simulation. doi:10.7148/2016 ISBN: 978-0-9932440-2-5 30th European Conference on Modelling and Simulation, Regensburg Germany, May 31st – June 3rd, 2016
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Abstract:	We study the influence of ripple waves, originating from the electromechanical effects, on band structures of graphene nanoribbons (GNRs)- GNRs are complex systems that require novel approaches for their analysis, due to multiscale and multiphysics effects involved. Here, we develop a mathematical model and we show that the externally applied magnetic fields along z-direction in combination with pseudo-fields enhance the spin splitting of GNRs bands. In particular, we show that the strain tensor induce quantum confinement effect that turn to lead the opening of the bandgaps at Dirac point- Such finite band gaps are highly sensitive to the control parameters (period length, applied stress) of the ripple waves that help to design the optoelectronic devices for straintronic and spintronic applications.

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$\varepsilon \quad \varepsilon$

$$\varepsilon \quad = -(\partial \quad + \partial \quad + \partial \quad \partial \quad) \qquad (\ )$$

$$(\quad) = (\quad)$$

$$\varepsilon \quad = \partial \quad + -(\partial \quad) \qquad (\ )$$

$$\varepsilon \quad = \partial \quad + -(\partial \quad) \qquad (\ )$$

$$\varepsilon \quad = -(\partial \quad + \partial \quad) + -(\partial \quad)(\partial \quad) \qquad (\ )$$

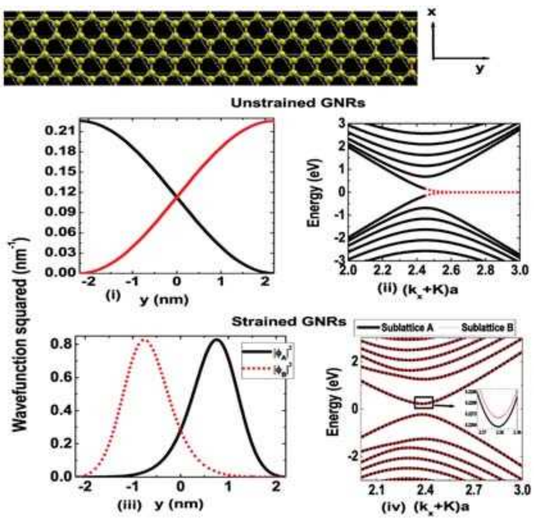
$\sigma \quad = \partial \quad \partial\varepsilon$

$$\sigma \quad = \quad \varepsilon \quad + \quad \varepsilon \qquad (\ )$$

$$\sigma \quad = \quad \varepsilon \quad + \quad \varepsilon \qquad (\ )$$

$$\sigma \quad = \quad \varepsilon \qquad (\ )$$

$$\partial \ \sigma \quad + \quad =$$



$$(\quad \partial \ + \quad \partial \ ) \ + (\quad + \quad) \partial \ \partial$$
$$+ - \partial \left[\ (\partial \quad) + \quad (\partial \quad) \right]$$
$$+ \quad \partial \ (\partial \quad)(\partial \quad) + — \qquad (\ )$$

$$(\quad \partial \ + \quad \partial \ ) \ + (\quad + \quad) \partial \ \partial$$
$$+ - \partial \left[\ (\partial \quad) + \quad (\partial \quad) \right]$$
$$+ \quad \partial \ (\partial \quad)(\partial \quad) + — \qquad (\ )$$

$\sqrt{\ }$

τ

$= \tau \quad (\ ) \qquad = \tau \quad (\ )$

$= \pi \quad \iota \quad \iota$

$$\partial \quad = \qquad (\ )$$

$= \quad \varepsilon \ \varepsilon$

$\partial \quad = \quad (\;) \quad = \pi$

$(\quad \partial + \quad \partial) \; + (\quad + \quad) \partial \, \partial$

$= - \quad (\quad) + \quad (\;) \; (\;)$

$- \frac{\tau}{\quad} \; (\;) \qquad (\;)$

$(\quad \partial + \quad \partial) \; + (\quad + \quad) \partial \, \partial$

$= - \quad (\quad) + \quad (\;) \; (\;)$

$- \frac{\tau}{\quad} \; (\;) \qquad (\;)$

ε

$\varepsilon \quad = \frac{\tau}{\quad} \; (\;) + - \quad + \frac{}{} \; (\;) - \frac{\tau}{\quad} \; \left(\frac{}{} \right) (\;)$

π

$= \; (\sigma \quad + \sigma \quad) + - \quad \mu \quad \sigma \qquad (\;)$

$= \; - \eta \; - \qquad = - \eta \partial$

$= (- \varepsilon \quad) \beta$

$= \; (- \quad)$

$\psi = \varepsilon \psi \qquad \psi (\;) = \quad (\quad) (\phi \; (\;) \; \phi \; (\;))$

$\left(\quad - \partial \; + \frac{\beta}{} \varepsilon \; + \frac{}{\eta} \right) \phi \; = \left(\frac{\varepsilon - \quad \mu}{\eta} \right) \phi \qquad (\;)$

$\left(\quad + \partial \; + \frac{\beta}{} \varepsilon \; + \frac{}{\eta} \right) \phi \; = \left(\frac{\varepsilon + \quad \mu}{\eta} \right) \phi \qquad (\;)$

$(\quad - \partial \;) \phi \; = \left(\frac{\varepsilon}{\eta} \right) \phi \qquad (\;)$

$(\quad + \partial \;) \phi \; = \left(\frac{\varepsilon}{\eta} \right) \phi \qquad (\;)$

$(\quad + \partial \;)$

$(\eta \quad) \; (\quad - \partial \;) \phi \; = \varepsilon \; \phi \qquad (\;)$

$\varepsilon_{\pm} = \pm \sqrt{ (\eta \quad) \; (\quad - \quad) } \qquad (\;)$

$(- \quad) = (\quad - \;) \; (\quad + \;) \qquad (\;)$

$=$

$= \quad (\quad) \qquad (\;)$

$\varepsilon_{\pm} = \pm \sqrt{ (\eta \quad) \; (\quad + \quad) } \qquad (\;)$

$\phi \; (\;) \qquad \phi \; (\;)$

$\phi \quad = \frac{}{\varepsilon_{\pm}} \{ \quad (\quad) - \quad (\quad) \} \qquad (\;)$

$\phi \; = \quad (\quad) \; (\;)$

$\langle \phi \; (\;) \; \phi \; (\;) \rangle = \langle \phi \; (\;) \; \phi \; (\;) \rangle$

$=$

$\langle \phi \; (\;) \; \phi \; (\;) \rangle + \langle \phi \; (\;) \; \phi \; (\;) \rangle =$

$= \frac{(\varepsilon \quad)}{\kappa + \quad (\quad - \quad (\quad))} \qquad (\;)$

$\kappa = (\quad - \quad + (\varepsilon \quad) \; \{ \quad - \quad (\quad) \}) \qquad (\;)$

$=$

$\phi \quad = \mu \frac{}{\sqrt{\quad}} \quad \left[\frac{(\quad + \;) \pi}{\quad} \right] \qquad (\;)$

$\phi \quad = \mu \frac{}{\sqrt{\quad}} \quad \left[\frac{(\quad + \;) \pi}{\quad} \right] \qquad (\;)$

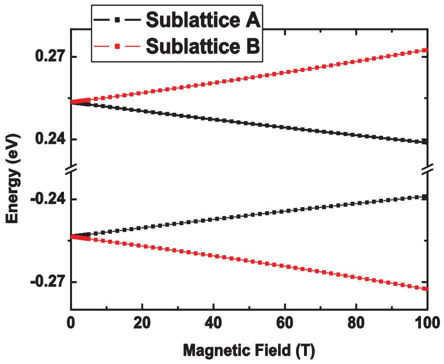
$= \quad \Lambda$

$\left(\quad + \partial \; + \frac{\beta}{} \varepsilon \; + \frac{}{\eta} \right)$

$\left(\quad - \partial \; + \frac{\beta}{} \varepsilon \; + \frac{}{\eta} \right)$

$$(\eta \quad)\begin{bmatrix} -\partial \; + \left(\frac{\beta}{\quad}\right) \varepsilon \; + \left(\frac{\quad}{\eta}\right) \quad + \frac{\beta}{\quad}\left(\partial \; \varepsilon \; - \varepsilon \; \partial \;\right) \\ + \frac{\quad}{\eta}\left(\partial \; - \; \partial \;\right) + \; + \frac{\beta}{\quad}\varepsilon \quad + \frac{\quad}{\eta} \\ + \; \frac{\beta}{\eta}\varepsilon \quad + - \left(\frac{\mu}{\eta}\right) \end{bmatrix} \phi \; = \varepsilon \; \phi \qquad (\quad)$$

$$(\eta \quad)\begin{bmatrix} -\partial \; + \left(\frac{\beta}{\quad}\right) \varepsilon \; + \left(\frac{\quad}{\eta}\right) \quad - \frac{\beta}{\quad}\left(\partial \; \varepsilon \; - \varepsilon \; \partial \;\right) \\ - \frac{\quad}{\eta}\left(\partial \; - \; \partial \;\right) + \; + \frac{\beta}{\quad}\varepsilon \quad + \frac{\quad}{\eta} \\ + \; \frac{\beta}{\eta}\varepsilon \quad + - \left(\frac{\mu}{\eta}\right) \end{bmatrix} \phi \; = \varepsilon \; \phi \qquad (\quad)$$



$\sqrt{\quad}$

τ

$=$ $=$