TEACHING PHYSICS WITH ANGRY BIRDS:

Momentum and energy conservation laws

IFIMUP–IN
Material Physics
Institute of the
University of Porto

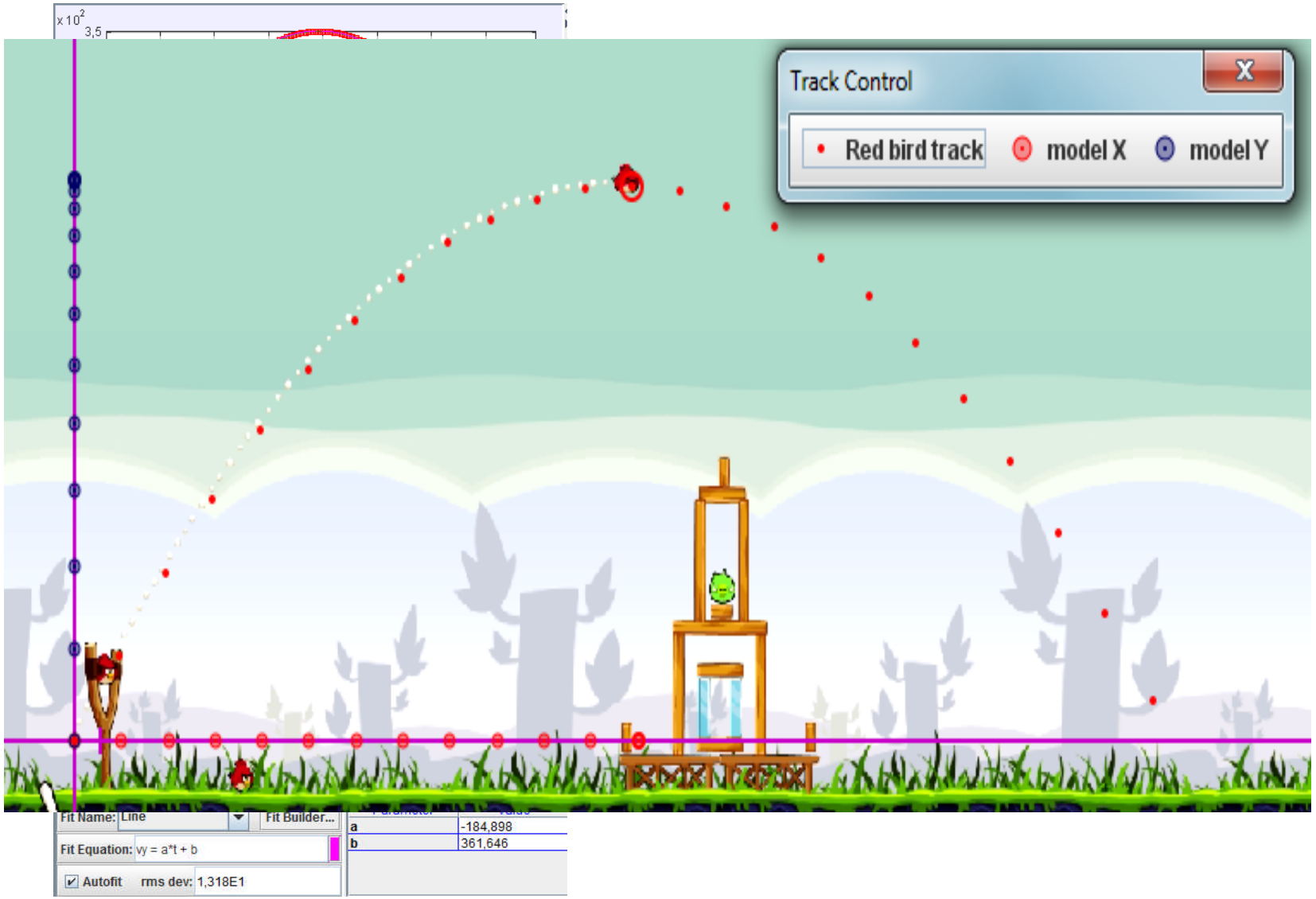
Paulo Simeão Carvalho
Marcelo Rodrigues

Department of Physics and Astronomy, FCUP, Portugal

FACULDADE DE CIÊNCIAS
UNIVERSIDADE DO PORTO

IFIMUP–IN
Material Physics
Institute of the
University of Porto

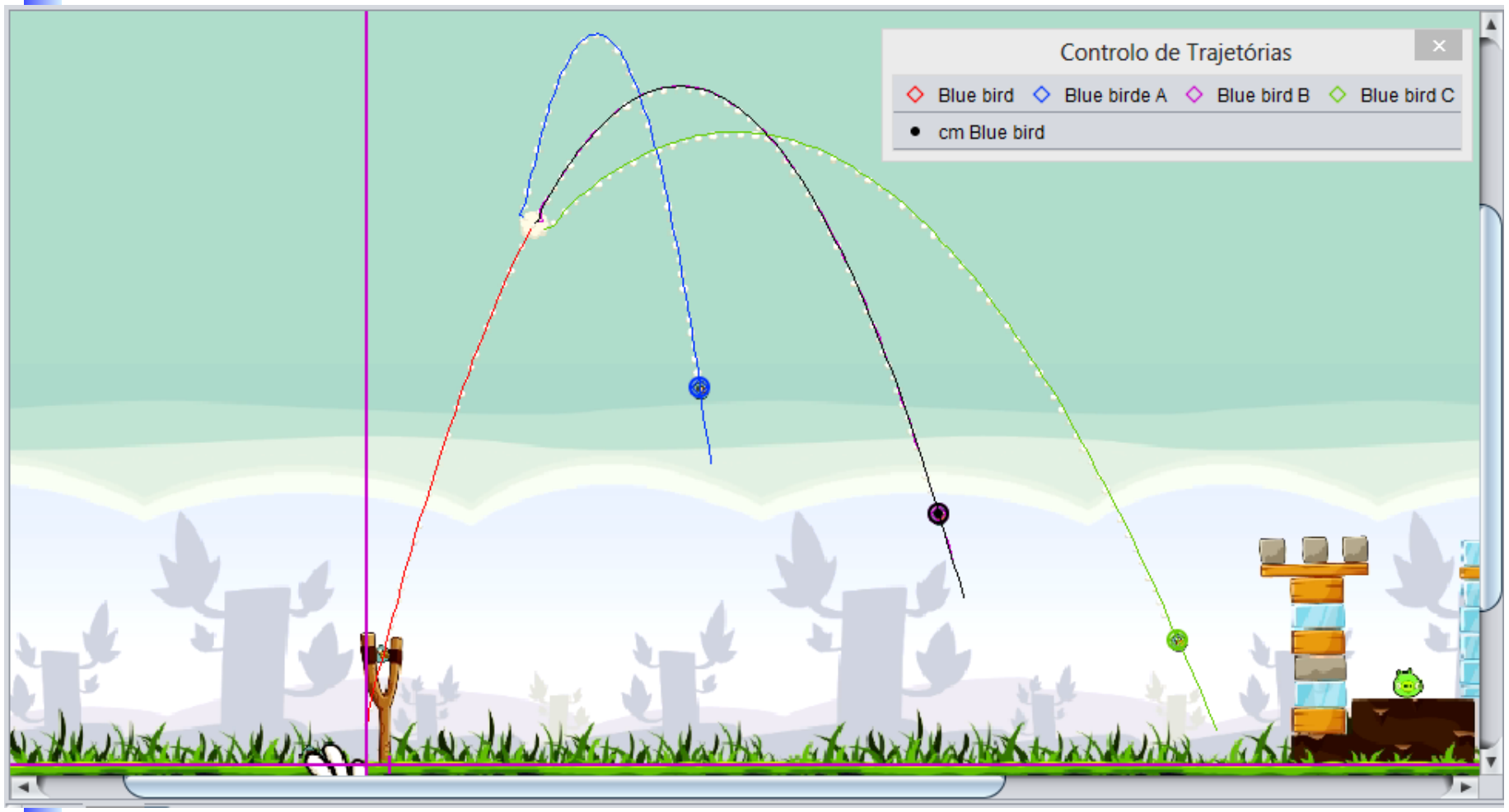
Red bird



FACULDADE DE CIÊNCIAS
UNIVERSIDADE DO PORTO

IFIMUP–IN
Material Physics
Institute of the
University of Porto

Blue bird



FACULDADE DE CIÊNCIAS
UNIVERSIDADE DO PORTO

IFIMUP–IN
Material Physics Institute of the University of Porto

VIDEO BASED EXPERIMENTAL ACTIVITIES (VBEA)

	Blue bird	Blue bird A	Blue bird B	Blue bird C
v_x	5,7	2,5	5,7	8,9
v_y	11,2	12,9	11,2	9,5

$$M = m_A + m_B + m_C$$

$$1 = \alpha_A + \alpha_B + \alpha_C$$

Momentum convervation law

$$v_o = \alpha_A v_A + \alpha_B v_B + \alpha_C v_C$$

$$v_o = v_B \xrightarrow[\text{results}]{\text{Experimental}} \alpha_A = \alpha_C = \alpha$$

$$\alpha_B = 1 - 2\alpha$$

Energy convervation law

$$v_o^2 = \alpha_A v\downarrow A \uparrow 2 + \alpha_B v\downarrow B \uparrow 2 + \alpha_C v\downarrow C \uparrow 2$$

$$v_o = v_B \xrightarrow[\text{results}]{\text{Experimental}} \alpha_B = 1 - 2\alpha$$

$$v_o^2 = v\downarrow B \uparrow 2 + \alpha(v\downarrow A \uparrow 2 + v\downarrow C \uparrow 2 - 2 v\downarrow B \uparrow 2)$$

FACULDADE DE CIÊNCIAS
UNIVERSIDADE DO PORTO

IFIMUP–IN
Material Physics
Institute of the
University of Porto

Conservation laws...

Momentum convervation law

Energy convervation law

EXPLOSION

$$v_0^2 < \alpha_A v_A^2 + \alpha_B v_B^2 + \alpha_C v_C^2$$

FACULDADE DE CIÊNCIAS
UNIVERSIDADE DO PORTO

IFIMUP–IN
Material Physics
Institute of the
University of Porto

With Angry Birds we can …

- Collect experimental data
- Analyse data and graphics and interpret results by physical models
- Apply conservation laws to experimental data
- Discuss why momentum is conserved and why energy may not be conserved
- **Make use of critical reasoning (*heads-on*)**

References:

[1] Brown, D. (2008). Video Modeling: Combining Dynamic Model Simulations with Traditional Video Analysis, *American Association of Physics Teachers (AAPT) Summer Meeting*, Edmonton.

[2] Brown, D., Cox, A.J. (2009). Innovative Uses of Video Analysis, *The Physics Teacher*, 47, 145-150.

[3] Rodrigues, M, Carvalho, P.S. (2013). Teaching Physics with Angry Birds*:* Exploring the kinematics and dynamics of the game, *Physics Education*, in the press.

[4] IGN (2009). Angry Birds Review, *IGN.com*.

[5] MacIsaac, D. (2011). Angry Birds: The physics phenomenon, *The Physics Teacher*, 49, 399.

[6] Allain, R. (2010a). The Physics of *Angry Birds*.

[7] Allain, R. (2010b). Does the Angry Blue Bird multiply its mass?.

[8] Allain, R. (2012). The Gravitational Force in *Angry Birds Space.*

[9] Rovio Entertainment Ltd. (2012). Angry Birds Star Wars.

Thank you !