

Some Physics of Well Hit Balls



David Kagan

Professor of Physics Emeritus
California State University, Chico

AKA: Dr. Baseball, Ph.D.

MajorLeaguePhysics.org
DrBaseballPhD@gmail.com

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Just for
Dan Brooks....

Statcast
FOR
DUMMIES

STEVE PEARCE, 1B
TOTAL DISTANCE: 17 FT 6 IN

MLB.com
STATCAST

HITTER
#35 ERIC HOSMER
HIT TRAVEL TIME: 1.87 SEC

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The advertisement features a baseball field scene with a batter, pitcher, and fielders. A white arc shows the ball's trajectory from the pitcher to the batter. A blue arc shows the ball's path from the batter to the catcher. The 'STATCAST' logo is prominently displayed in the center, flanked by blue arrows. The background is a bright yellow banner with the title 'Statcast FOR DUMMIES' in white and yellow text. At the bottom, there is a yellow banner with the slogan 'A Reference for the Rest of Us!' and a small cartoon character icon next to the text 'FREE eTips at dummies.com'.

From the Statcast Glossary

Statcast collects data using a series of high-resolution optical cameras along with radar equipment. The technology precisely tracks the location and movements of the ball and every player on the field, resulting in an unparalleled amount of information covering everything from the pitcher to the batter to baserunners and defensive players.

Two Pieces of the 2015 Data Set to be Used:

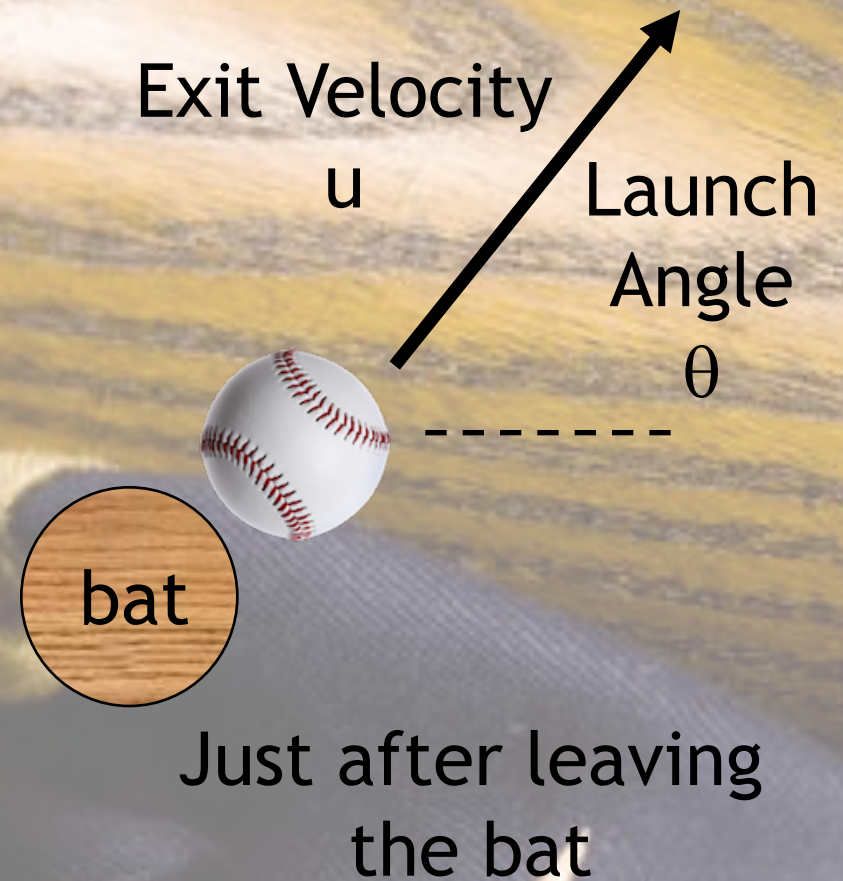
Exit velocity: Velocity of the ball off the bat on batted balls.

Launch angle: The vertical angle at which the ball leaves the bat on a batted ball.

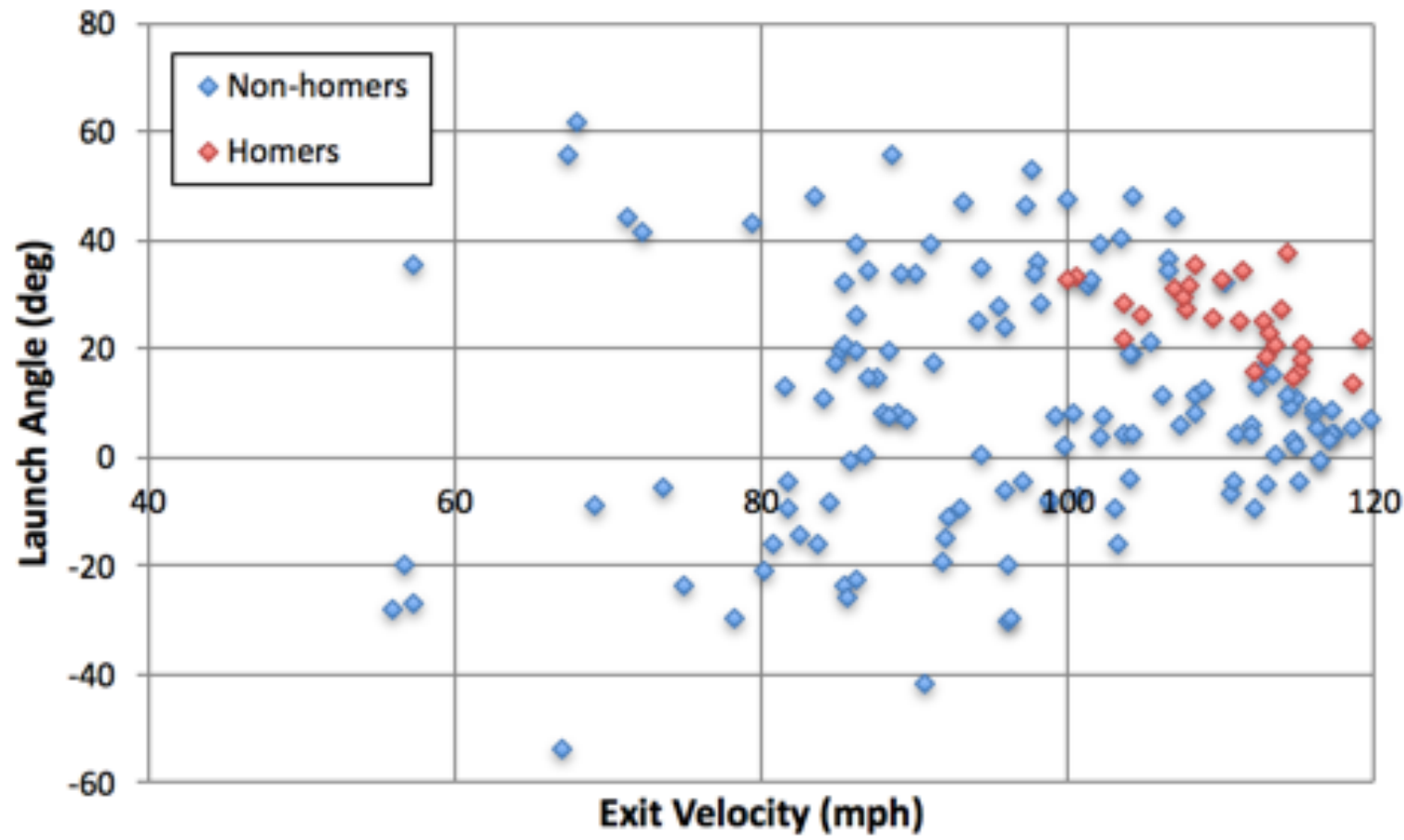
Statcast FOR DUMMIES

Exit velocity: Velocity of the ball off the bat on batted balls.

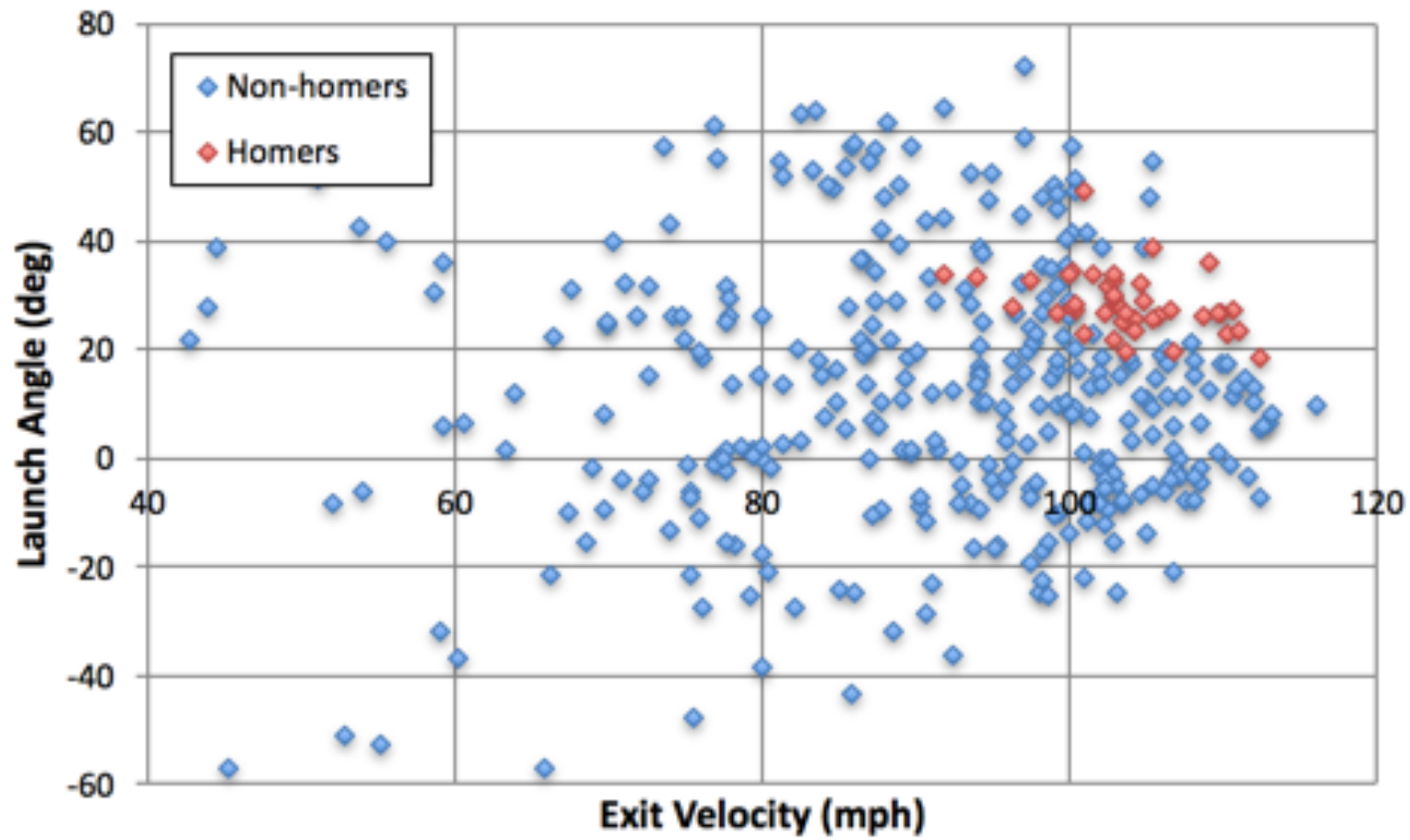
Launch angle: The vertical angle at which the ball leaves the bat on a batted ball.



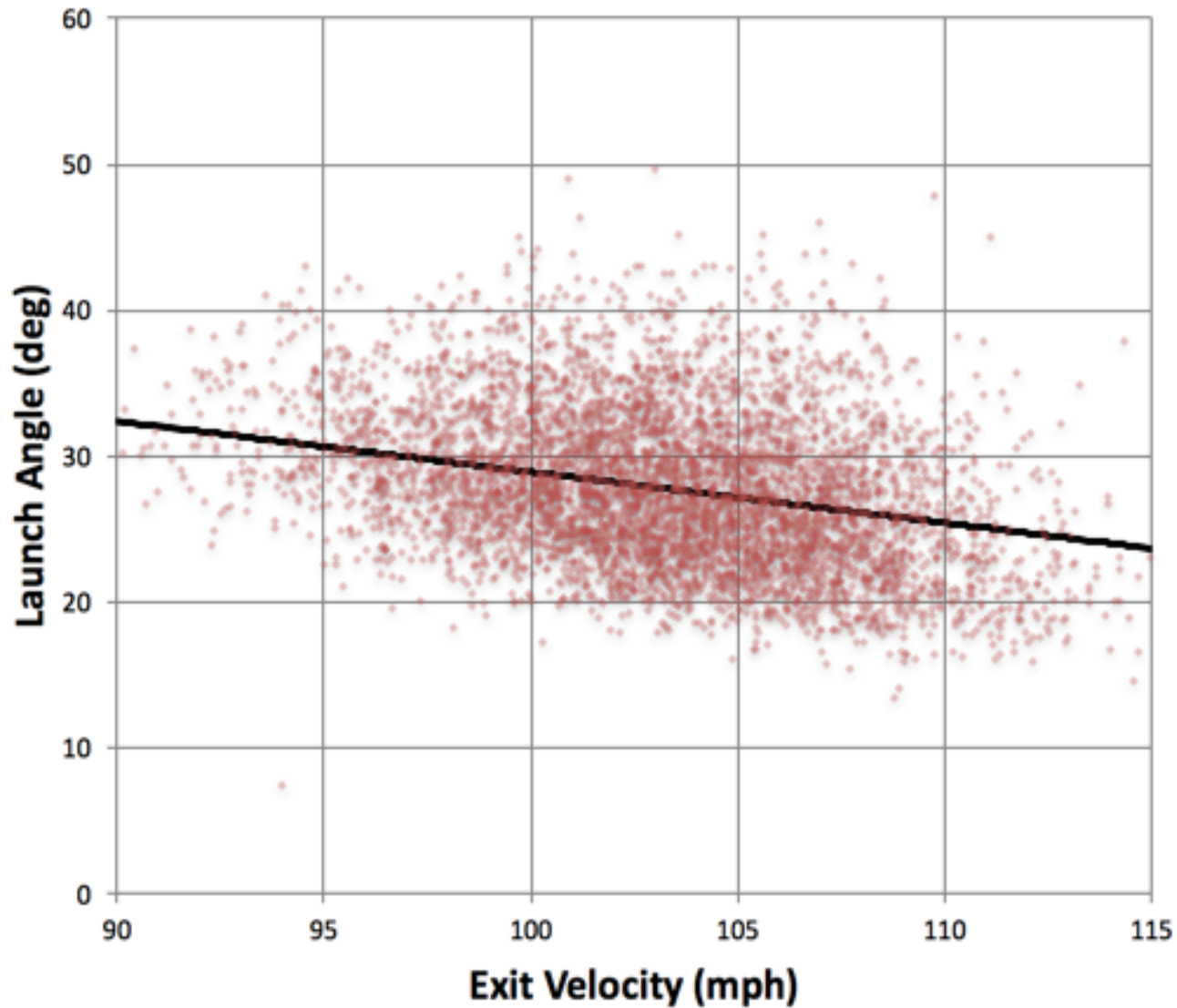
Angle vs Exit Velocity - Stanton



Angle vs Exit Velocity - Harper



Launch Angle vs. Exit Velocity Home Runs Only



All Homers in 2015

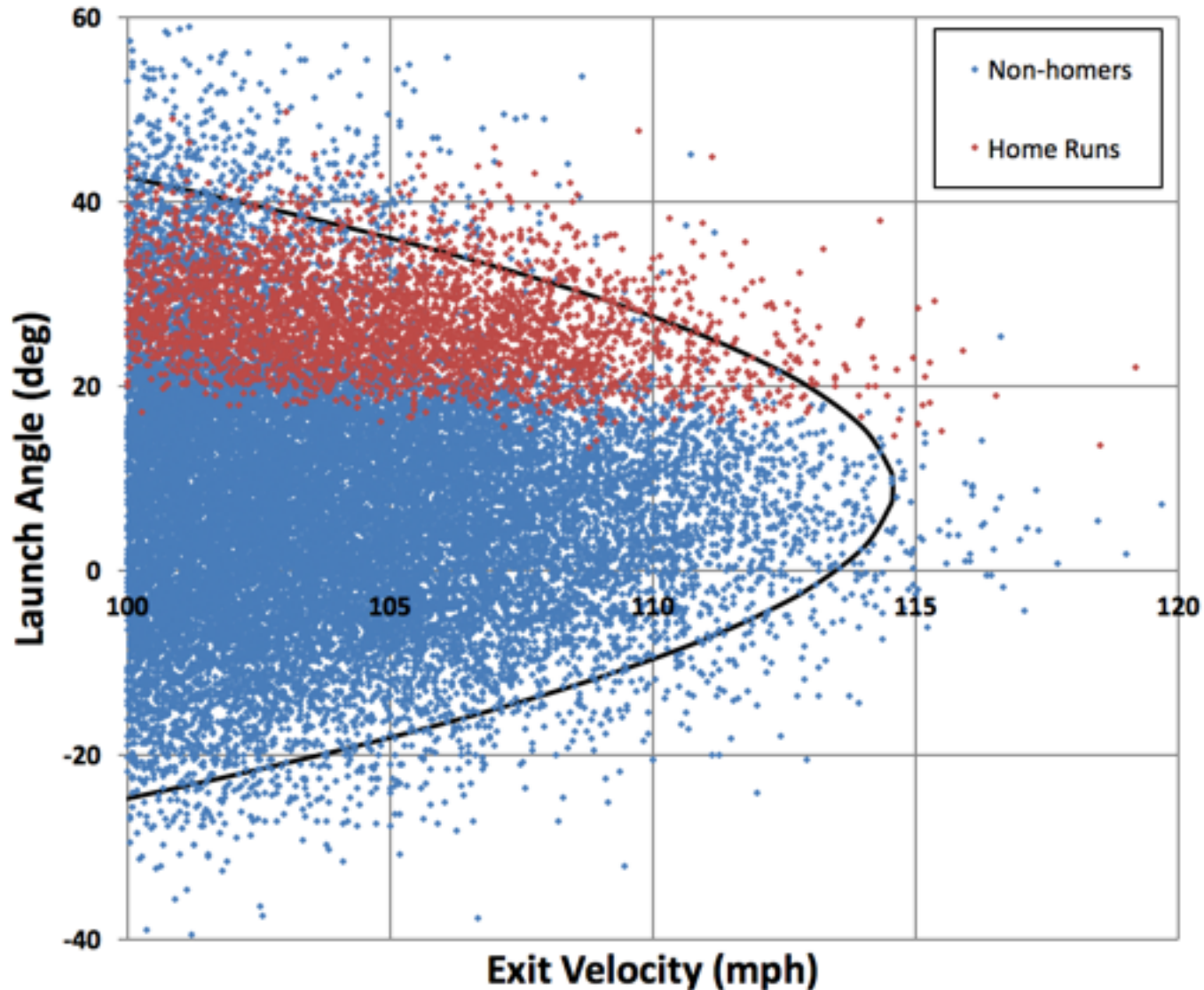
They form a cluster.

- Launch angles 15 to 45 degrees.
- Exit Velocity 90 to 115 mph.

Lower velocity requires higher launch angle - high fly ball.

Higher velocity for lower launch angles - line drive homer.

Launch Angle vs. Exit Velocity
All Batters 2015



Back to the Launch Angle vs. Exit Velocity

The arrow shape is real, not an illusion for the best batters.

Before we go into any physics, let's use some "common sense" from a game of eight ball.

The Physics of Pool

Direct
Hit



Indirect
Hit



The Physics of Baseball

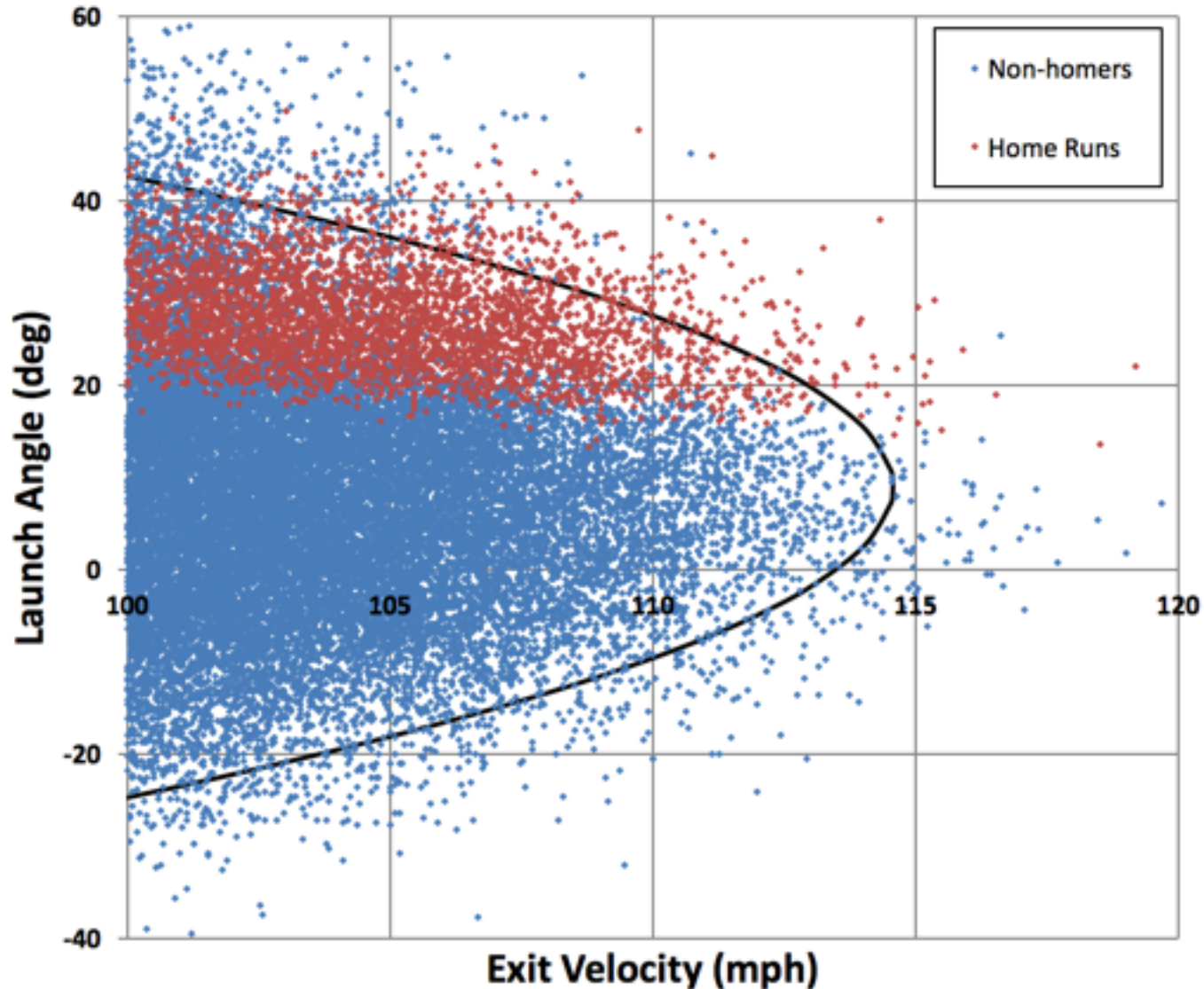
Direct
Hit
“on the
screws”



Indirect
Hit



Launch Angle vs. Exit Velocity
All Batters 2015



“Common Sense”
tells us:

- For a given launch angle, there is a maximum speed.
- For lower launch angles this speed is larger.

The arrow is explained!

**But as my wife often
reminds me,
“Common sense is
neither!”**



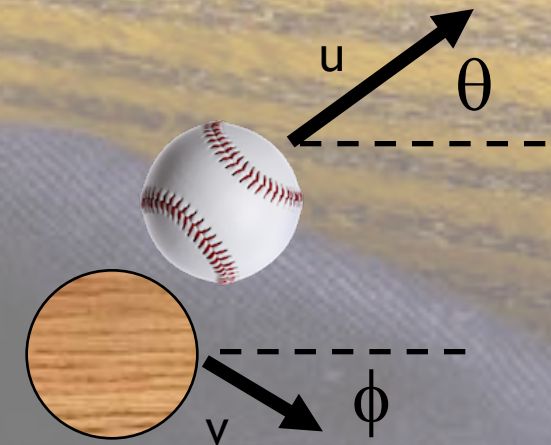
Some Physics of the Ball-Bat Collision

Our Goal

Explain the plots of the launch angle θ versus the exit velocity u .



Just before collision



Just after collision

Some Physics of the Ball-Bat Collision

Physics Principles:

Linear Momentum is conserved:

$$0 = M u \sin\theta - m v \sin\phi$$

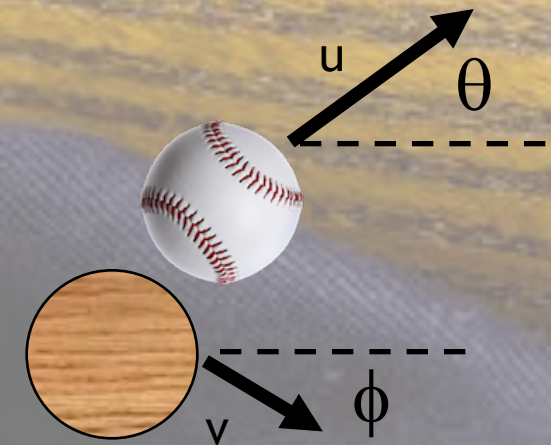
$$M v_0 - m u_0 = M v \cos\phi + m u \cos\theta$$

Some mechanical energy is lost during the collision:

$$\frac{1}{2} m u^2 + \frac{1}{2} M v^2 = e \left(\frac{1}{2} m u_0^2 + \frac{1}{2} M v_0^2 \right)$$

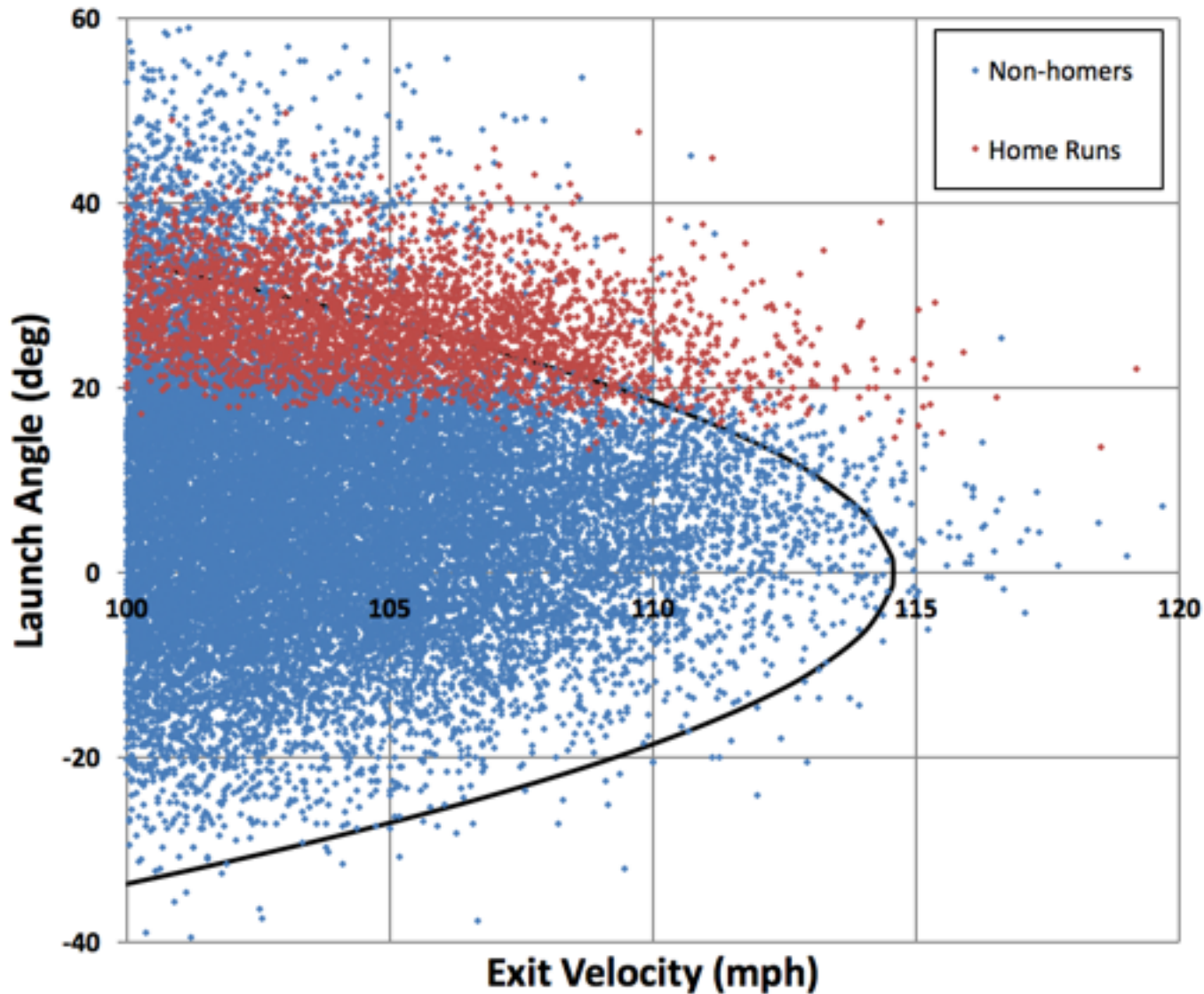


Just before collision



Just after collision

Launch Angle vs. Exit Velocity
All Batters 2015

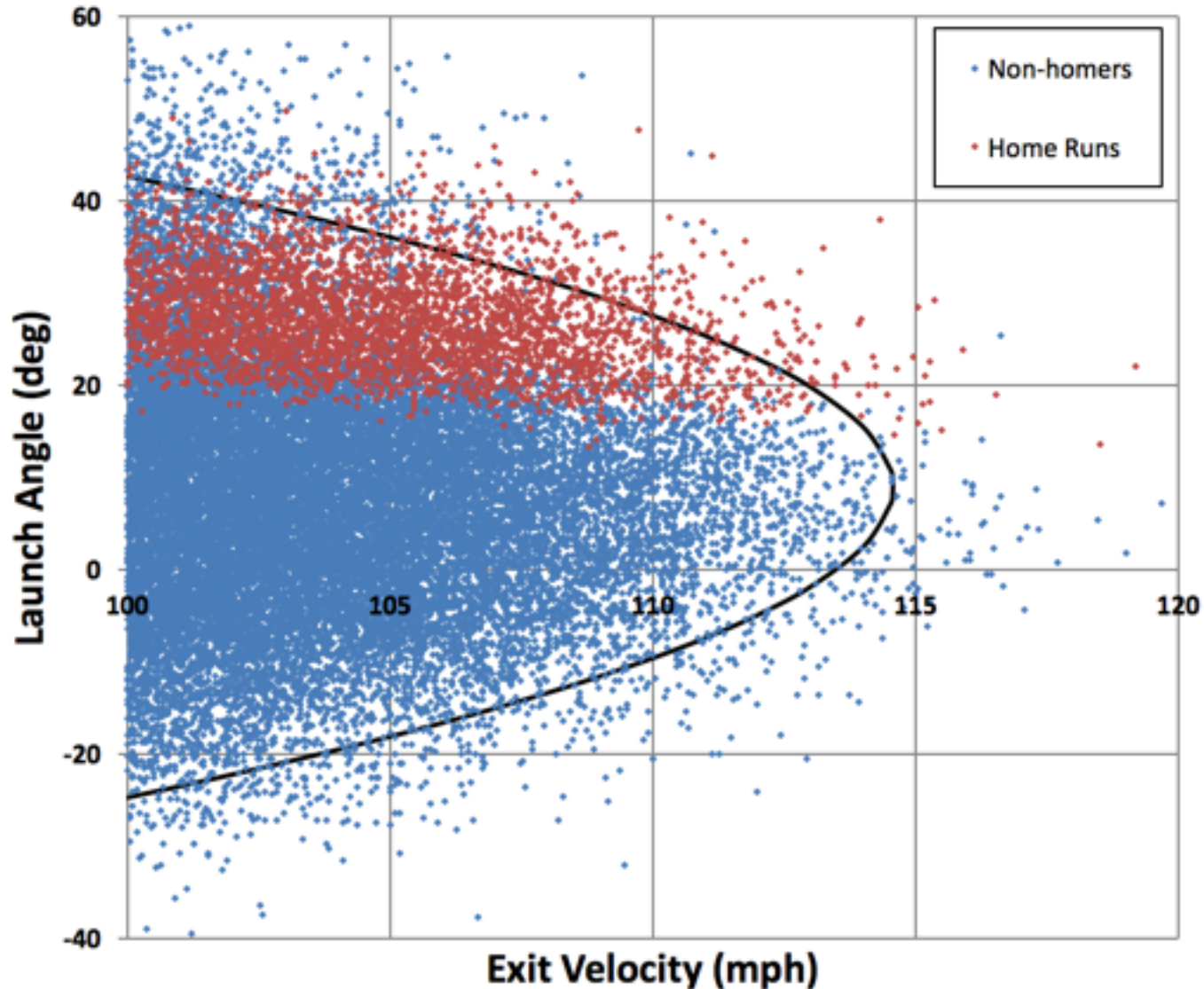


Here's the best I
could do:

- $v_o = 70$ mph
- $u_o = 90$ mph
- $e = 58\%$

There is something
wrong.

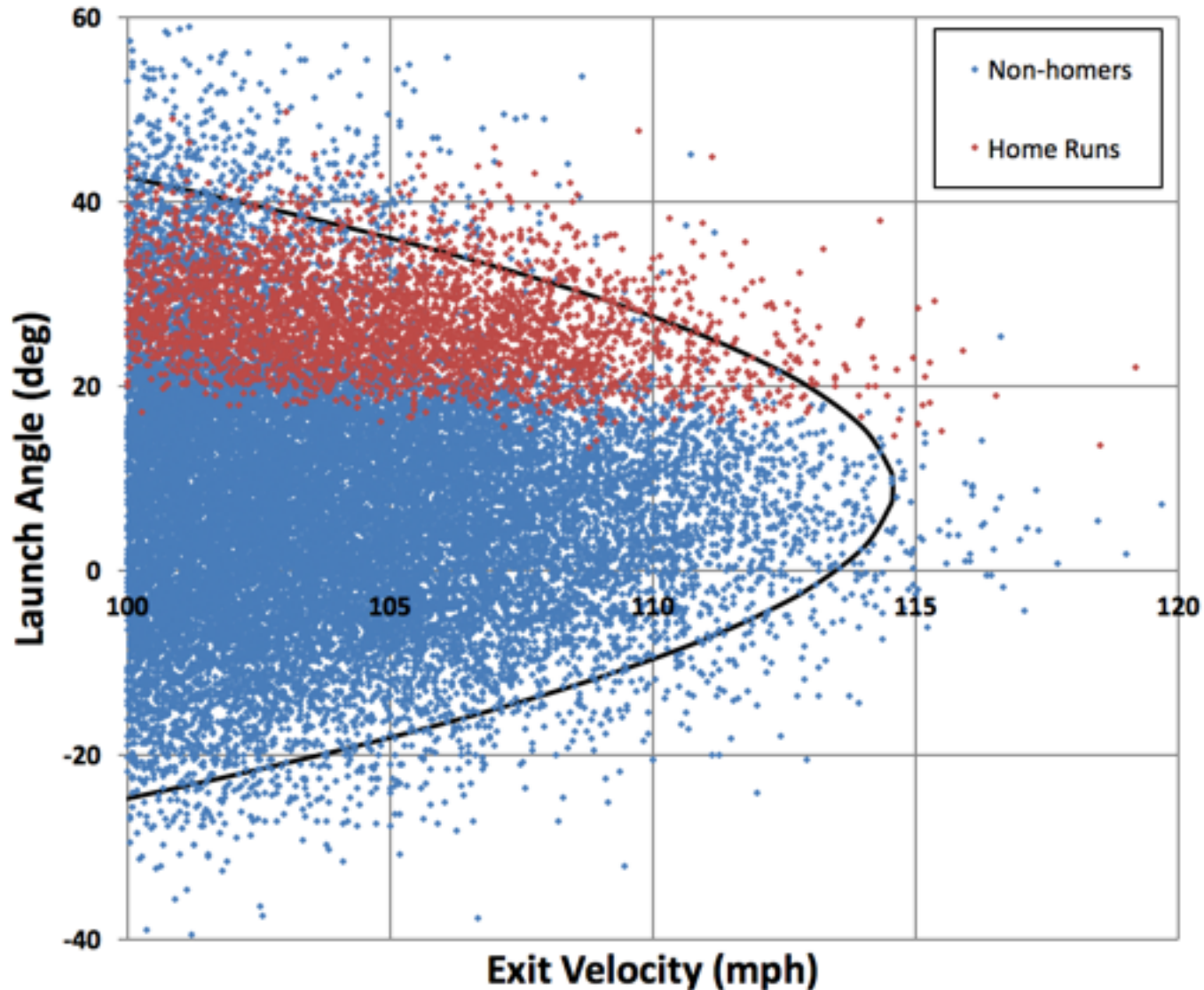
Launch Angle vs. Exit Velocity
All Batters 2015



Lifting the
curve 9°
gives this
beautiful fit!

What gives?

Launch Angle vs. Exit Velocity
All Batters 2015



**Batters typically
have an upper
cut that biases
the launch
angle upward!**

A close-up photograph of a wooden baseball bat and a baseball. The bat is positioned diagonally across the frame, with its handle on the left and its head on the right. The wood grain of the bat is clearly visible. The baseball is in the foreground, slightly to the left of the bat's head. The background is a blue fabric with a subtle pattern. The text is centered on a black rectangular overlay.

Ichiro
Suzuki's
3000th Hit

What have we learned?

Plots of Launch Angle vs. Exit Speed form an arrow because:

- For a given launch angle, there is a maximum speed.
- For lower launch angles this speed is larger.

Homers form a cluster.

- Launch angles 15 to 45 degrees.
- Exit Velocity 90 to 115 mph.

Is it Physics Or “Common Sense?”

For more physics and baseball visit:



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