

## Birch and Swinnerton-Dyer Conjecture Clay Institute Millenium Problem Solution

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### Abstract

This paper presents the solution to the Birch Swimmerton problem. It entails the use of critical damping of a Mass-Spring-Dash Pod system which, when modelled mathematically, provide the equation that allows the solution of the zeta problem to be solved.

**Keywords:** Zeta functions; Dash pod systems; Mean functions

### Introduction

But in special cases one can hope to say something. When the solutions are the points of an abelian variety, the Birch and Swinnerton-Dyer conjecture asserts that the size of the group of rational points is related to the behavior of an associated zeta function  $\zeta(s)$  near the point  $s=1$ . In particular this amazing conjecture asserts that if  $\zeta(1)$  is equal to 0, then there are an infinite number of rational points (solutions), and conversely, if  $\zeta(1)$  is not equal to 0, then there is only a finite number of such points [1].

### Explanation

#### Equation of motion

From Verruijt, we know the equation of motion for a mass -spring-dashpod system is:

$$m \cdot d^2u/dt^2 + c \cdot du/dt + ku = 0$$

So, taking the resonant frequency into account, the equation from Verruijt becomes:

$$d^2u/dt^2 + 2zw_0 \cdot du/dt + w_0^2 u = 0$$

Where  $w_0$  = resonant frequency and  $z$  is a measure of the system damping [2].

At critical damping, the characteristic equation is the golden mean function:

$$x = -1/[x-1]$$

Or,

$$x^2 - x - 1 = 0$$

The roots to this equation are, of course, -0.618 and 1.618.

Value for  $i$  - the imaginary number Now, before examining zeta  $z$  in equation form, we calculate a real value for the imaginary  $i = \sqrt{-1}$

$$[1-i] = 1/[(1-i)-1]$$

$$1-i = 1/-i$$

$$-i = 1/[1-i]$$

$$i = 1/[i-1]$$

$$x = 1/[x-1]$$

$$x = -0.618, 1.618$$

So,  $\sqrt{-1} = -0.618, 1.618$

### Damping ratio zeta z

Now, zeta =  $z$  = damping ratio =  $w/w_0$ :

$$du/dw = 0 : w/w_0 = \sqrt{[1-2z^2]}$$

Algebraically:

$$du/dw = dw$$

$$w = w_0 \cdot \sqrt{[1-2z^2]}$$

Taking the derivative:

$$du/dw = dw = w' = [w_0 \cdot (1-2z^2)^{1/2}]'$$

$$w_0/2 \cdot (1-2z^2)^{-1/2} \cdot (-4z) = 1.5$$

In the Birch conjecture, there are two possibilities to consider [3]. They are:

$$z(1) = 0 \text{ and } z(1) \neq 0$$

In the first case:

$$0 = w_0/3 \cdot [(1-2(1)^2)]^{1.5}$$

$$0 = w_0/3(11.5)$$

$$W_0 = 0$$

$$Z(1) = 0, w_0 = 0$$

### Critical damping

In the second case, we have critical damping,  $z(1) \neq 0$

$$\text{Say } z(1) = 1$$

$$1 = w_0/3 \cdot [(1-2(1)^2)]^{1.5} \quad w_0 = 3$$

Or  $w_0 = C_1$   $w_0$  is a real number. In case 1 again:

$$Z(1) = 0, w_0 = 0$$

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$$du / dw = 0 \quad w / w_0 = \sqrt{[(1-2z^2)]}$$

$$w / 0 = [(1-2(z)2)] \quad w=0$$

$w/w_0=0/0$  Dividing by zero has infinite solution. Now, finally, in the critical damping case:

$$du / dw = 0 \quad w / w_0 = \sqrt{[(1-2(z)2)]} \quad w / C1 = \sqrt{[(1-2(1)2)]}$$

$$w = \sqrt{(-1)}(c1)$$

We know  $\sqrt{(-1)} = -0.618, 1.618$ . So,  $w = -0.618$  Or  $1.618$   $w/w_0 = 0.618$   $C1/C1 = 0.618$ . Therefore there is a real solution to  $z$  at critical damping [4,5].

## Conclusion

Simple Mechanics combined with knowledge of the zeta function

and the value of the imaginary number provides the ingredients to solve the Birch and Swinnerton-Dyer Conjecture.

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