SCIENCES & BIOENGINEERING SCIENCES

The Research Group

Algebra, Incidence Geometry (ALGB)

has the honor to invite you to the public defense of the PhD thesis of

Jordy VANPOUCKE

to obtain the degree of Doctor of Sciences

Title of the PhD thesis:

Bounds on Costas permutations and graphs.

Promotor:

Prof. dr. Philippe Cara

The defense will take place on

Friday October 26 2018 at 17:00 h

in Auditorium D.0.07 at the campus Humanities, Sciences and Engineering of the Vrije Universiteit Brussel, Pleinlaan 2 - 1050 Elsene, and will be followed by a reception.

Members of the jury:

Prof. dr. Stefaan Caenepeel (chairman)
Prof. dr. Ann Dooms (secretary)
Dr. Jan De Beule
Dr. Sara Rottey (UGent)
Prof. dr. Michele D'Adderio (ULB)

Curriculum vitae

In 2012, Jordy Vanpoucke obtained a Master's degree in mathematics at the University of Gent, after which he became a teaching assistant at the VUB Faculty of Engineering and started a PhD in Mathematics under the supervision of Prof. dr. Philippe Cara.

The resulting research was published in several peer-reviewed journals and has been presented internationally at conferences and workshops.

Abstract of the PhD research

RADAR and SONAR systems are both used to transmit waves to detect a certain target and determine certain properties of this target, such as the distance and the velocity. The waves used in SONAR are frequency pulses that are reflected from the target. When the pulse is received back by the observer, it is shifted in both time and frequency and these shifts can be used to compute the distance from the target and the velocity of the target. While transmitting it is possible that background noise or interference with other objects will influence the received frequency pulse. For this reason one chooses to use a pattern of different frequencies within one pulse and the most effective patterns appear to be the Costas ones.

As early as 1965 people started searching for this type of frequency patterns, also called Costas permutations, and they came up with three general constructions. It seems however that they only cover a small fraction of all the Costas permutations, which leads us to two important open questions: Are there other construction algorithms for Costas permutations? Given a natural number n greater than 1, does a Costas permutation of degree n exist?

In this thesis we contribute to the search for new Costas permutations by introducing two tools that can be used to determine if a permutation is Costas. The first tool are the so called alternating runs, for which we found a theorem for general values of the degree n of the permutation and the number of alternating runs k in this permutation. A second tool that we used is that of subgraphs in Costas graphs. More specifically we look at complete graphs appearing in those Costas graphs and we present several theorems in which we determine the largest possible complete subgraph in a Costas graph and an upper bound on the smallest possible complete subgraph included in all Costas graphs of given order n.

The new results in this thesis can be useful when searching for Costas permutations (graphs), as they give specific conditions on the structure of these permutations (graphs). This can then be used in computer programs to reduce the time needed for these programs to find new Costas permutations.