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# THE SMOOTH CUBIC SURFACES WITH 15 LINES

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## Abstract

It is well-known that a smooth cubic surface has 27 lines over an algebraically closed field. If the field is not closed, however, fewer lines are possible. The next possible case is that of smooth cubic surfaces with 15 lines. This work is a contribution to the problem of classifying smooth cubic surfaces with 15 lines over fields of positive characteristic. We present an algorithm to classify such surfaces over small finite fields. Our classification algorithm is based on a new normal form of the equation of a cubic surface with 15 lines and at most 10 Eckardt points. The case of cubic surfaces with more than 10 Eckardt points is dealt with separately. Classification results for fields of order at most 13 are presented and a verification using an enumerative formula of Das is performed. Our work is based on a generalization of the old result due to Cayley and Salmon that there are 27 lines if the field is algebraically closed. Along the way, we show that the line-intersection graph of smooth cubic surfaces with 15 lines is unique.

**Date :** Friday, December 3, 2021

**Time:** 17:00

**Place:** IMBM, Bođaziçi University South Campus