This inquiry investigates the geometric and structural features of the wooden ceiling covering the nave of the Cappella Palatina in the Royal Palace (Palazzo Reale) of Palermo. I do not offer here either an in-depth historical analysis or a detailed description of the rich and interesting paintings decorating the ceiling. Such issues have been widely investigated, mainly by art and architecture historians. Rather, a brief discussion of the history of the Cappella is meant to draw attention to some of the previous studies on the cultural influences underlying the artistic and architectural features of this building in order to contextualize my findings on the geometric layout of the ceiling covering the nave.

Today, the ceiling of the nave of the Cappella Palatina appears to be the sole surviving example of this type of complex, painted carpentry in Islamic culture. Given the absence of other similar examples, it could be argued that the ceiling is the peculiar product of multicultural Norman Sicily, and reflects the influence of its patron, Roger II (r. 1130–54). It is distinguished from similar artifacts in Islamic art mainly by the material of which it is made and the technique used to construct it. Most muqarnas vaults are made of stone or stucco, with single elements that are carved or molded. In the ceiling of the Cappella Palatina, however, the spatial layout of the muqarnas is produced by a segmentation of the form: that is, it is divided into arch-shaped primary panels and into secondary hidden panels, which act as centerings for the placement of thin wooden elements that form the surface of the small vaults. No other ceiling like that of the nave of the Cappella Palatina has survived in Sicily, but we will see that it must have served as the inspiration for the consoles of a later ceiling in Palermo.

This first study of the geometric and constructive features of the ceiling is just one contribution to the research that has been conducted regarding the origin of the craftsmen and the cultural influences underlying the ceiling and its creation. The precise drawing of a reference grid, which will be described below, and the relations between that grid and the drawing of the shape of the vertical primary elements, referred to as “EL” panels in the following discussion, demonstrate that the ceiling was meant to be not a peripheral creation but a unique and magnificent expression of Islamic culture. The Norman kingdom put an end to two centuries of Islamic domination in Sicily, even as it maintained relations with Islamic countries in North Africa and demonstrated an appreciation for Islamic art and architecture. The establishment of the Norman kingdom did not interrupt the influence of Islamic culture on art and architecture in Sicily. We see the remains of this impact in the ceiling of the Cappella Palatina, as well as in some palaces in Palermo that are still standing—the Zisa, the Cuba, and the Scibene—all of which were commissioned by Norman kings.

METHODOLOGY AND THESIS

Between 2005 and 2009, the Cappella Palatina underwent an accurate and comprehensive restoration, financed by a generous grant from Reinhold Wurth and directed by the Soprintendenza per i Beni Culturali of Palermo. The provisional structures used by the restorers allowed for new and closer views of the mosaics and other decorations, and gave researchers the chance to observe the ceiling from a privileged per-
Some of the best previous inquiries on the Cappella presumably also used provisional structures, either to get detailed photographs, such as, for instance, the ones published in Ugo Monneret de Villard’s *Le pitture musulmane al soffitto della Cappella Palatina in Palermo*, or to survey the ceiling. The precise drawings done by Andrea Terzi in the late nineteenth century, which are discussed below, must have been based on measurements and observations attainable at that time only by actually touching the ceiling by hand.4

The results of the research here reported are based on 3D laser-scanning data of the eastern end of the wooden ceiling and on a survey of the dimensions of the entire nave. Indeed, 3D laser scanning has profoundly transformed the approach to cultural heritage analysis and documentation. Laser scanners quickly measure the 3D coordinates of a large number of points (usually referred to as a “point cloud”) of the visible surfaces of an object; they also photograph the scanned area and link color values (RGB) to each surveyed point. With 3D laser scanning, scholars are able to examine an artifact in detail, allowing for both geometric analyses and the study of the quality and position of any colored feature. The 3D scanners are usually classified as long, medium, or close-range, depending on the distance allowable between the device and the object. The data measured in this inquiry were collected via a close-range optical triangulation laser scanner,5 a highly accurate device that can detect distances of less than 1 millimeter; it is usually positioned at about 1.5 meters from the object and the scan is performed in a few seconds. Several scans of the area under examination were collected; they were registered to form one point cloud, which became the basis for the geometric analysis described in this paper.

There have been several studies devoted to the geometric analysis of the muqarnas vaults, mainly as a way to reconstruct the horizontal grid pattern of the vaults. The analysis of the elevation has often been regarded as a secondary matter, since it was assumed that the height of the tiers of the muqarnas was determined by the dimensions of the vaults and by the 1:2 ratio of the sides of the rectangle inscribing the basic element, in accordance with the description furnished by al-Kashi in his treatise *Miftā/hšdotbelow al-/hšdotbelowisāb* (Key to Arithmetic). Laser scanning and 3D modeling software allow in-depth inspection of the three-dimensional features of the muqarnas vaults, offering the opportunity for new studies on the relations between the grid patterns and the elevations.

As indicated above, laser scanners have generally been considered an effective technology for documenting cultural heritage; they are particularly useful with respect to the issue of conservation. In this study, I attempt to demonstrate that laser-scanning data can be employed to reconstruct the “reference drawing” of the ceiling of the Cappella Palatina and that relations between the reference grid and the elevation of the muqarnas vaults can be discerned by means of 3D metric data. I argue that this relation should not be regarded as a distinguishing feature of the ceiling of the Cappella Palatina, but rather as a common practice of craftsmen in Islamic and in premodern European art and architecture: “[I]n the Topkapi and Tashkent scrolls abstract designs generated from modular geometric grids unencumbered by specific measurements were meant to be proportionally adapted to buildings and local materials at the construction time.... Elevations were deduced by means of geometric procedures also common to Gothic building practice in which learning the method of projecting three-dimensional forms from two-dimensional templates played a central role.”6

THE CAPPELLA PALATINA AND ITS CEILING

The Cappella Palatina is located in the Royal Palace of Palermo, at the western edge of the historical town (fig. 1). The history of the foundation and construction of the Royal Palace, though widely investigated, is still uncertain. What seems definite is that the site was selected as the residence of the Normans when Robert Guiscard (d. 1085) and his brother, Count Roger (d. 1101), conquered Palermo in 1072. They began building the palace on the ruins of a previously fortified site, as a counterpart to the fortified Muslim residence located by the sea at the eastern edge of the old town. Count Roger’s son, Roger II (d. 1154), took advantage of the succession dispute that broke out following the death of Pope Honorius II, and was proclaimed king of Sicily by Anacletus II (d. 1138) in December 1130.7 We know that Roger II was the patron of the Cappella Palatina (fig. 2).