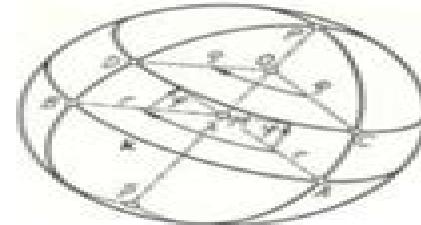


## Geometrie der Erde und des Himmels

### Übung 1 (Elementare Kugelgeometrie)

1. a) Wo liegen alle Kugelpunkte, die von einem festen Kugelpunkt  $P$  denselben sphärischen Abstand  $\alpha$  haben? (Beispiele:  $\alpha = 60^\circ, 90^\circ, 120^\circ$ )  
 b) Wie gross ist der Radius  $\rho$  des entstandenen Kreises für  $\alpha = 60^\circ, 90^\circ, 120^\circ$ , beliebig?  
 Für welchen Wert von  $\alpha$  ist  $\rho$  maximal?  
 c) Welche Zirkelöffnung ist nötig, um die Kreise für  $\alpha = 60^\circ$  und  $\alpha = 90^\circ$  auf einem Globus vom Radius  $r$  (z.B.  $r = 20\text{cm}$ ) einzuziehen?
2. In der Figur ist  $P$  der Rechtspol des Grosskreises  $k$  durch  $A$  und  $B$ . Die Winkel  $\lambda = 120^\circ$  und  $\varphi = 30^\circ$  sowie der Radius  $r = 6370\text{ km}$  (Erdradius) seien gegeben.  
 a) Berechnen Sie den sphärischen Abstand der Punktpaare  $(C, P)$ ,  $(D, P)$  und  $(A, B)$  im Längenmass.  
 b) Bestimmen Sie die Länge des Kleinkreisbogens  $\overset{*}{CD}$ , die Länge der Sehne  $CD$  sowie den sphärischen Abstand von  $C$  und  $D$ .
3. Wie viele Prozent der Kugeloberfläche umfasst ein Kugeldreieck mit  
 a)  $\alpha = \beta = \gamma = 90^\circ$     b)  $\alpha = 70^\circ, \beta = 80^\circ, \gamma = 120^\circ$     c)  $\alpha = \beta = \gamma = 135^\circ$
4. Unter dem **sphärischen Excess**  $\varepsilon$  eines Eulerschen Kugeldreiecks mit den Winkeln  $\alpha, \beta, \gamma$  versteht man die Differenz  $\varepsilon = \alpha + \beta + \gamma - 180^\circ$ .  
 Zeigen Sie: Wird der sphärische Excess  $\varepsilon$  im Bogenmass gemessen, so gilt für den Inhalt  $F$  der Dreiecksfläche:  $F = r^2 \cdot \varepsilon$ . Was bedeutet also  $\varepsilon$ , wenn  $r = 1$  ist?
5. Wie viele Quadratkilometer misst auf der nördlichen Erdhalbkugel die Fläche zwischen dem Nullmeridian und dem Längenkreis  $75^\circ\text{ W}$ ? (Erdradius:  $6370\text{ km}$ )
6. *Polardreieck* (Figur 5)  
 a) Verifizieren Sie: Ist das Kugeldreieck  $A'B'C'$  Polardreieck zum Kugeldreieck  $ABC$ , so ist auch das Dreieck  $ABC$  Polardreieck zum Dreieck  $A'B'C'$ .  
 b) Zeigen Sie: Ist  $c = \overset{*}{AB}$  eine Seite eines Kugeldreiecks und  $\gamma'$  der Winkel in der entsprechenden Ecke  $C'$  des Polardreiecks, so gilt  $c + \gamma' = 180^\circ$ . Betrachten Sie dazu die Winkel in der Grosskreisebene durch  $A$  und  $B$ .
7. a) Bei welchem Dreieck fallen Polardreieck und Gegendreieck zusammen?  
 b) Welche Eigenschaften hat das Polardreieck eines gleichschenkligen, eines gleichseitigen, eines rechtwinkligen Kugeldreiecks?  
 c) Berechnen Sie den Flächeninhalt des Polardreiecks zum Kugeldreieck  $ABC$  mit den Seiten  $a = 80^\circ, b = 100^\circ, c = 120^\circ$ .



# Elementare Kugelgeometrie

**AW Rasmussen**

## **Elementare Kugelgeometrie:**

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**Course of Study for the Preparation of Rural School Teachers, Nature Study, Elementary Agriculture, Sanitary Science, and Applied Chemistry** David Eugene Smith,Edward Douglas Greenman,Fred Mutchler,Henry Stoddard  
Curtis,International Commission on the Teaching of Mathematics,Mary Adelaide Nutting,Mrs. Fannie Fern (Phillips)  
Andrews,William Heard Kilpatrick,William Starr Myers,William James Craig,1912      **Unsolved and Unsolvable Problems in Geometry** Herbert Meschkowski,1966      **Geometrie auf der Kugel** Berthold Schuppar,2016-10-19 In diesem Buch werden wesentliche Fragen der elementaren Geometrie auf der Kugeloberfläche und ihre Anwendungen auf die Erd und Himmelskugel mathematische Geografie und Astronomie so aufgegriffen und beantwortet dass sie als Hintergrundwissen für einen realitätsnahen Geometriunterricht in der Sekundarstufe zur Verfügung stehen Im Mittelpunkt stehen alltägliche Phänomene wie z.B. geografische Koordinaten Kompasskarte Wege Sonnenlauf Zeit Weltkarten sodass Studierende im Sinne Freudenthals nicht angewandte Mathematik lernen sondern Mathematik anwenden lernen Reflexionen zur Modellierung sowie historische Aspekte runden die Betrachtungen ab Die Theorie wird nur so weit entwickelt wie es für diese Ziele erforderlich ist Digitale Werkzeuge werden dort eingesetzt wo es notwendig und sinnvoll erscheint Jedes Kapitel bietet eine reichhaltige Aufgabensammlung      **Vorlesungen über höhere Geometrie** Felix Klein,1926      **Kugelgeometrie**  
Hans-Günther Bigalke,1984      *Einleitung in die höhere Geometrie. 1. Vorlesung, gehalten im Wintersemester 1892 - 93*  
Felix Klein,1893      *International Catalogue of Scientific Literature*,1915      **Ungelöste und unlösbare Probleme der Geometrie** Herbert Meschkowski,2013-03-09      *Bulletin*,1912      **International Catalogue of Scientific Literature, 1901-1914**,1906      *Bulletin - Bureau of Education* United States. Bureau of Education,1912      **Einleitung in die höhere Geometrie ...** Felix Klein,1907      *International Catalogue of Scientific Literature*,1968      *Bulletin* United States. Office of Education,1912      Kreis und Kugel Wilhelm Blaschke,1916      **Kreis und Kugel** Wilhelm Blaschke,2021-03-22 Keine ausführliche Beschreibung für Kreis und Kugel verfügbar      *Eine Disziplin und ihre Verleger* Ute Schneider,Volker Remmert,2014-03-15 Am Beispiel der Mathematik werden in diesem Buch die Wechselwirkungen zwischen wissenschaftlichem Verlagswesen und der Entwicklung einer wissenschaftlichen Disziplin in Deutschland zwischen 1871 und 1949 analysiert Die Studie untersucht die Funktion unterschiedlicher Publikationsformen für die Scientific Community die Profilierungsstrategien der Verlage angesichts steigender Konkurrenz in ihrem Marktsegment sowie wissenschafts- und branchenexterne Rahmenbedingungen des mathematischen Publizierens      **Das Wesen der Mathematik** Walter Lietzmann,2013-03-08 Altere Lehrbücher der Mathematik pflegten damit zu beginnen die Frage nach dem Wesen der Mathematik und ihrer einzelnen Teilgebiete zu beantworten ja geradezu Definitionen dieser Begriffe zu geben Wir sind heute davon abgekommen Mit Recht Denn eine solche Frage gehört nicht an den Anfang sondern an den Schluss einer

gewissen Beschäftigung mit Mathematik Erst wenn man bereits etwas von der Mathematik kennengelernt hat erscheint es angebracht sich einmal über die mathematische Methode über den Aufbau des Lehrgutes und über seine Grundlage klarzuwerden Es haben zahlreiche frühere Lehrpläne für höhere Schulen einen wiederholenden Aufbau des Zahlbegriffes in die Oberklassen verlegt Es haben die Meraner Vorschläge und nach ihnen andere moderne Stoffpläne als Abschluß des mathematischen Unterrichts Rückblicke unter Heranziehung geschichtlicher und philosophischer Gesichtspunkte gefordert Die preußischen Richtlinien vom Jahre 1925 legten sowohl in den methodischen Bemerkungen wie in den Lehrplänen großen Nachdruck auf derartige philosophisch vertiefte Rückblicke Logik und Erkenntnistheorie finden einen Platz in der Mathematik Auch die psychologischen Grundlagen des mathematischen Denkens soll der Unterricht über hren Einzelfragen wie Zahlen und Raumvorstellungen sind nach Möglichkeit philosophisch zu vertiefen so heißt es in ihnen Auch die Marienauer Vorschläge 1945 um wenigstens einen der neuen Pläne zu nennen fordern Aufbau und Grundlage der Mathematik Entwicklung des Zahl und Funktionsbegriffes axiomatisches Verfahren der Grundlegung am Beispiel der Geometrie Ausblicke auf Logik und Erkenntnislehre

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